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IRON AND STEEL ENGINEER

SEPTEMBER • 1939

VOL. XVI NO. IX

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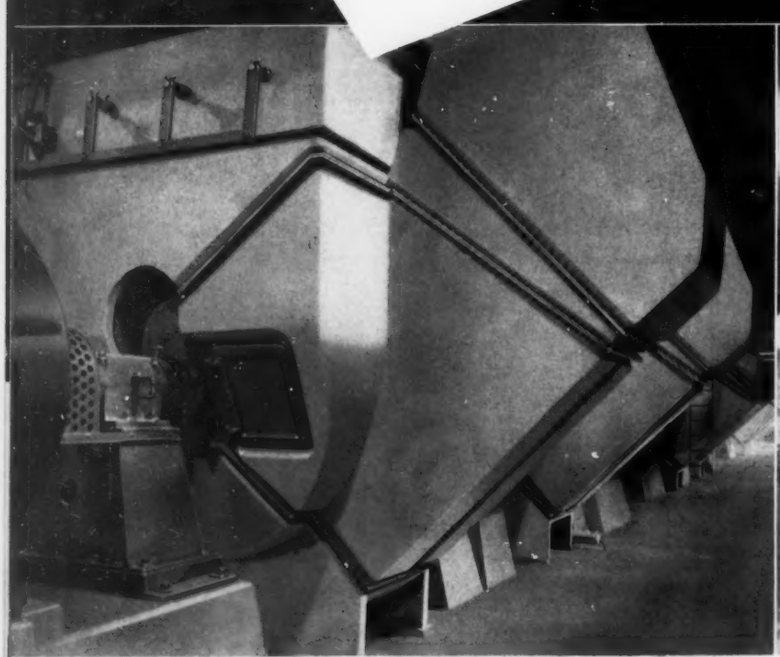
PLASTIC BINDING U. S. PATENT NO. 1970191 LICENSE NO. 11

PROGRESS IN STEEL



Three pairs of Sirocco Induced Draft Fans operating in parallel (2 fans per boiler) in a large steel mill power plant. A.H.S. Forced Draft Fans also serve this plant.

One of 8 pairs of Sirocco Induced Draft Fans for parallel operation (2 fans per boiler) in another leading steel mill. Sirocco Forced Draft Fans are also used at this plant.

• Steel . . . backbone of American industry . . . barometer of American business . . . pacemaker of progress. As steel goes, so goes the nation. The American Blower Corporation has kept pace with the progress of steel with the design and installation of specialized Mechanical Draft equipment in many of America's finest and most modern steel plants. American Blower engineers will gladly cooperate with you, whether your problem is producing steel or power for any product or process. Our years of experience in the manufacture of Forced and Induced Draft Fans, Fluid Drives (Hydraulic Couplings), Dust Precipitators, are always at your service. Write the factory or phone the nearest American Blower Branch Office. The services of American Blower engineers are yours without obligation.

AMERICAN BLOWER

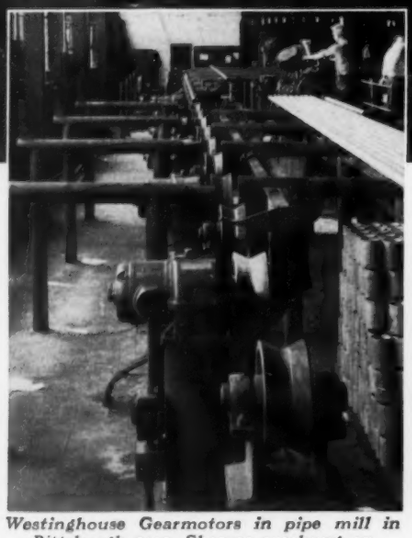
AMERICAN BLOWER CORPORATION

Division of American Radiator and Standard Sanitary Corp.

6000 Russell St., Detroit, Mich. • Canadian Sirocco Co., Ltd., Windsor, Ont.

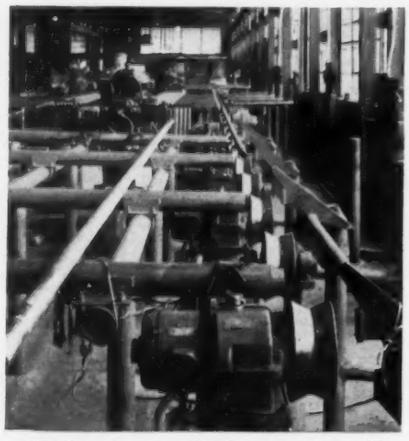
MODERN WESTINGHOUSE GEARMOTORS
add new flexibility in Pittsburgh steel mills

Battery of six Westinghouse D-C Gearmotors driving strip coiling units in Pittsburgh district cold-strip mill.



Westinghouse Gearmotors in pipe mill in Pittsburgh area. Sheaves overhung on gearmotor shafts convey pipe.

Slow speed end of coil-winding equipment, showing drums mounted directly on gearmotor shafts.



Another conveyor line in same pipe mill showing gearmotor drives.

Here's two examples of the benefits gearmotors bring to steel mill operations! Above, individual gearmotor drives for six cold-strip coiling units give new flexibility to pickling and coiling operations. Different materials requiring different pickling speeds can be handled simultaneously. Each coiling unit has its own motor and gear reduction which can be set for any speed desired. Production is more constant as any strip can be started or removed without stopping the others. Unloading of units can be staggered, giving more efficient utilization of operator's time.

In the pipe mill at left, gearmotors with overhung sheaves simplify conveying by eliminating coupled drives, pillow blocks and alignment difficulties. Why not check into *all* the benefits that Westinghouse Gearmotors offer? Ask or send for latest literature. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, Dept. 7-N. J-07131

W Westinghouse Geared Drives

WESTINGHOUSE ELECTRIC

GEARMOTORS · SPEED REDUCERS · GEARING

USE BONNOT-LENTZ BILLETEERS

SAVE MEN MONEY MATERIALS

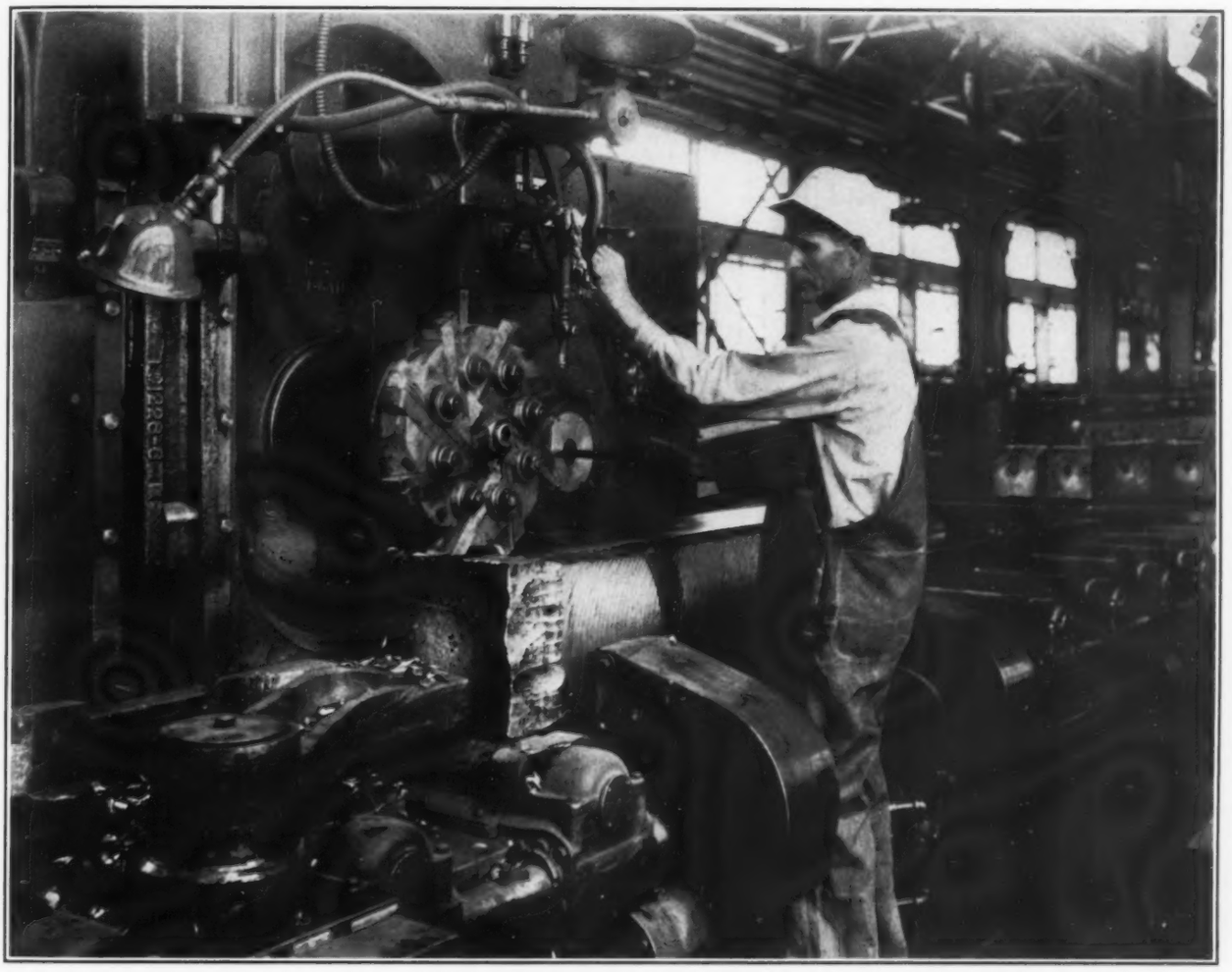


Photo showing eight-tool cutting head of Bonnot-Lentz Billeteer. This is one of several Billeteers which are in operation 24 hours per day in the plant of The International Nickel Company, Huntington, West Virginia.

STEEL EQUIPMENT DIVISION

THE BONNOT COMPANY

CANTON OHIO U.S.A.

Addition of
Sodium Fluoride
to the Ingot

Furnaces equipped with
Venturi Ports and
Sloping Back Walls

The above views show two of our Open Hearth Improvements. Other improvements include:

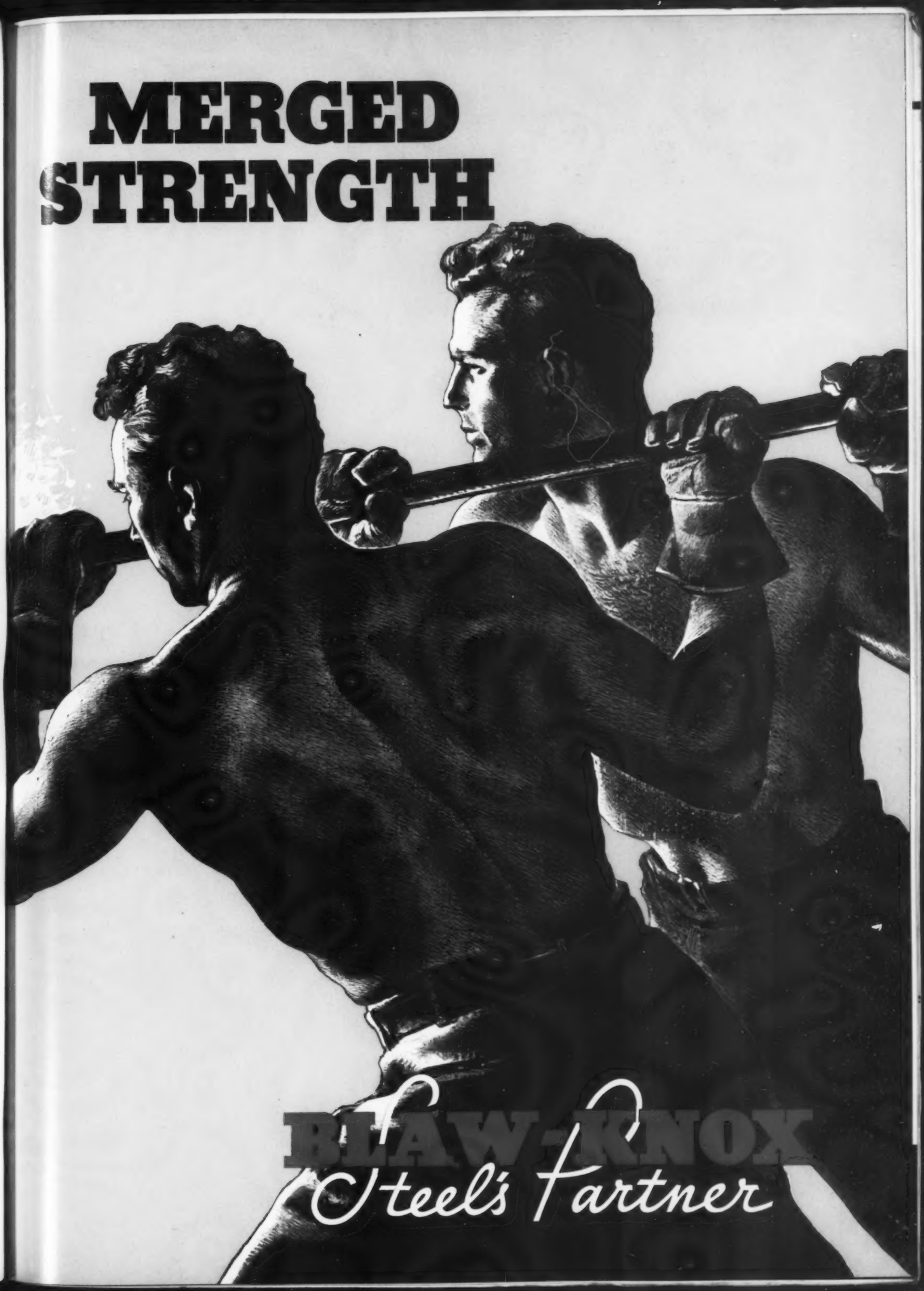
Danforth-Peterson Checkerwork
Fuel Mixing Burner
Tapered Door Frame

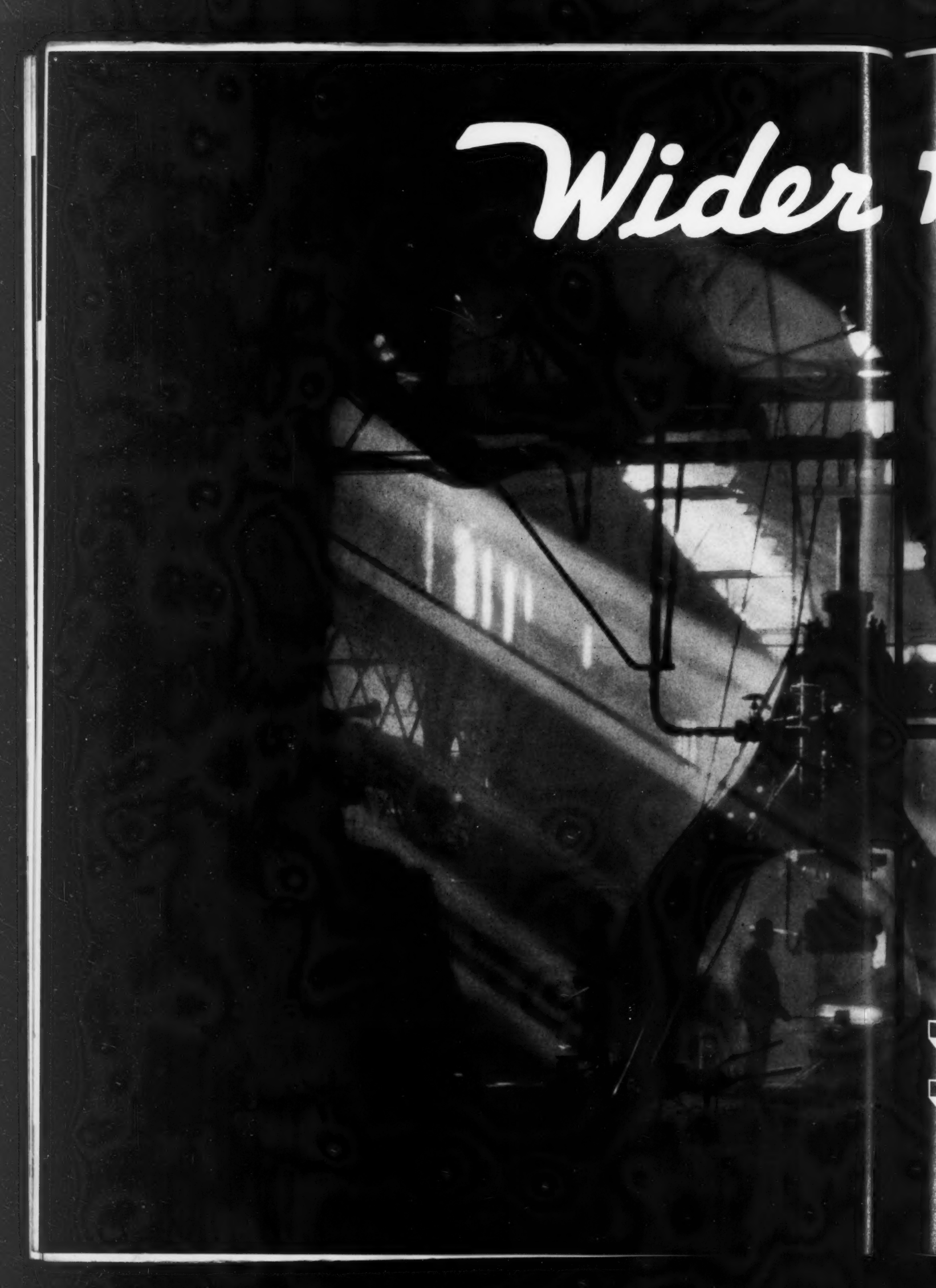
Open Hearth Combustion Company

GEO. L. DANFORTH, Jr., President

Licensors ***Designers*** ***Engineers***

310 South Michigan Avenue Chicago, Illinois


MERGED
STRENGTH
BLAW-KNOX
Steel's Partner


Wider

markets for STEEL

Blaw-Knox "serves steel" by unifying the resources of all of its divisions to offer new and sound engineering ideas built into steel products to meet a wide range of operating requirements.

Such service is extremely helpful in expanding present markets and creating new outlets for the use of steel because it *reduces production costs and enhances quality of products.*

BLAW-KNOX COMPANY

FARMERS BANK BUILDING, PITTSBURGH, PA.

NEW YORK PHILADELPHIA CHICAGO
BIRMINGHAM LONDON PARIS

THE NINE DIVISIONS OF BLAW-KNOX COMPANY AT YOUR SERVICE

Blaw-Knox Division • Lewis Foundry & Machine • National Alloy Steel • Pittsburgh Rolls • Union Steel Castings • Power Piping Division • Blaw-Knox Sprinkler Division • Gordon Lubricators • Electrochemical Processes Division

BLAW-KNOX

Steel's partner

BLAW-KNOX
Service to Steel

DIVISIONS OF BLAW-KNOX COMPANY
AND PARTIAL LIST OF PRODUCTS

BLAW-KNOX DIVISION, Blawnox, Pa.

Equipment for plants operating steel, glass, copper and other high temperature furnaces including water-cooled doors and frames, ports, valves, dampers, skewbacks, slag line coolers, bulkhead coolers, burner coolers, mantel coolers, buckstays, dolomite machines, door hoists, annealing boxes, covers and pots, galvanizing kettles, welded ladles, soaking pit covers, tin pots, spelter pans, grease kettles, hot blast valves, etc. Clamshell buckets; steel grating and treads; standard buildings; steam purifiers, gas cleaners, etc.

LEWIS FOUNDRY & MACHINE, Pittsburgh, Pa.

Chilled iron and iron alloy rolls for iron, steel, brass, copper, aluminum, zinc, nickel, rubber, paper, hot sheets, cold sheets, tin plate and strip, merchant bars and rods, etc. Rolling Mill machinery for the iron, steel and non-ferrous industries including: roll lathes, gear sets, mill drives, blooming mills, sheet mills, rod and strip mills, bar mills, billet mills, foil mills, continuous bar, billet and rod mills, cold mills for sheet and strip, merchant mills, rail rerolling mills, rail slitting mills, precision mills, roller and catcher tables, skin pass mills with edging stand and tension coiler, tilting tables, ingot turning machines, automatic screwdowns, hot and cold saws, shears, forging and straightening machines, rail breakers, roller levelers, stretcher levelers, rotary trimming shears for plates, mechanical annealing box stretchers, roll ragging attachments for blooming mill rolls, vertical edging mills, three high mills, roll grinders, etc.

GORDON LUBRICATORS, Pittsburgh, Pa.

Grease lubricating systems to handle extremely heavy viscous greases such as are used in steel plants and other industries operating heavy duty equipment. Grease lubricating equipment for overhead cranes and other machinery. Blaw-Knox lubricators are arranged for either automatic, semi-automatic or manual operation.

BLAW-KNOX SPRINKLER DIVISION, Pittsburgh, Pa.

Complete automatic sprinkler systems designed, manufactured and installed, guaranteed to meet all insurance requirements.

PITTSBURGH ROLLS, Pittsburgh, Pa.

PHOENIX IRON ROLLS FOR WEAR AND SURFACE: Phoenix Chill, Phoenix Moly Chill, Phoenix Nickel Chill, Phoenix Nickel Grain, Phoenix K Chill and Grain, Phoenix Special Rail Finishing, Phoenixloy, Pittsburgh Grade-working rolls for four high mills.

PHOENIX STEELIRON ROLLS FOR WEAR, SURFACE AND STRENGTH: Phoenix Metal, Phoenix Metal Master, Phoenix Sandaloy.

PHOENIX STEEL ROLLS FOR STRENGTH: Phoenix A Steel heat treated alloy, Phoenix A Special heat treated alloy, Piroco, Phoenix Carbon Steel.

POWER PIPING DIVISION, Pittsburgh, Pa.

Prefabricated power piping systems. Complete service in planning, designing, fabricating and installing piping for any pressures or temperatures.

NATIONAL ALLOY STEEL, Blawnox, Pa.

Special alloy castings for service under severe conditions, creating savings in operations especially with regard to problems involving high temperature, corrosion and abrasion.

UNION STEEL CASTINGS, Pittsburgh, Pa.

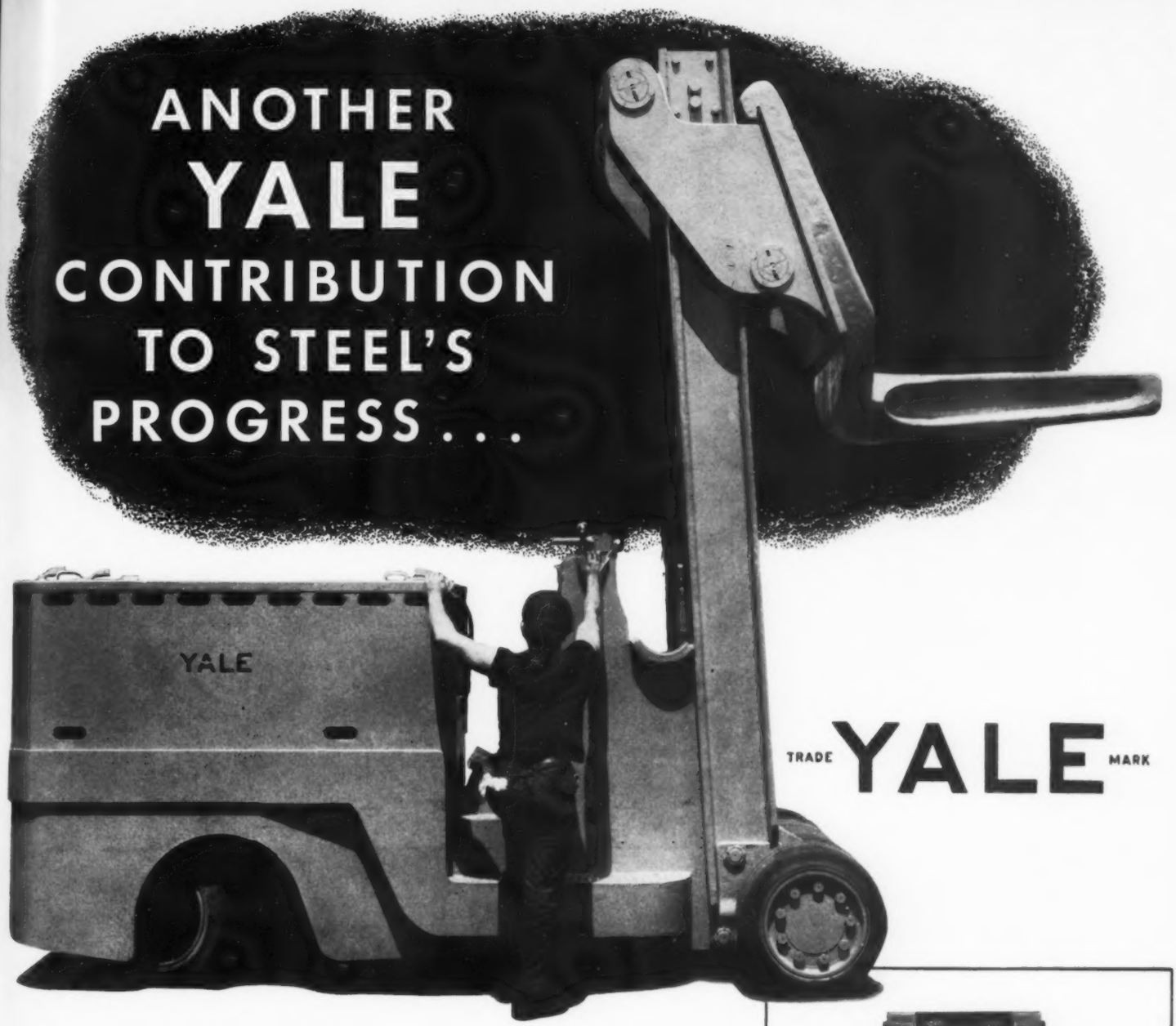
Spindles, coupling boxes and other steel mill castings of UNIVAN "C" to insure great strength and exceptional wearing qualities. Charging boxes made of tough UNIVAN alloy have longer life because of unusually high impact value.

ELECTROCHEMICAL PROCESSES DIVISION, Pittsburgh, Pa.

Complete continuous units for cleaning, pickling, finishing, rust proofing, coloring, plating of tin, terne, copper, zinc, brass, bronze, lead, nickel, and iron alloys.

BLAW-KNOX
Steel's Partner

ANOTHER YALE CONTRIBUTION TO STEEL'S PROGRESS . . .



TRADE YALE MARK

. . . THIS 25,000 LB. CAPACITY GIANT

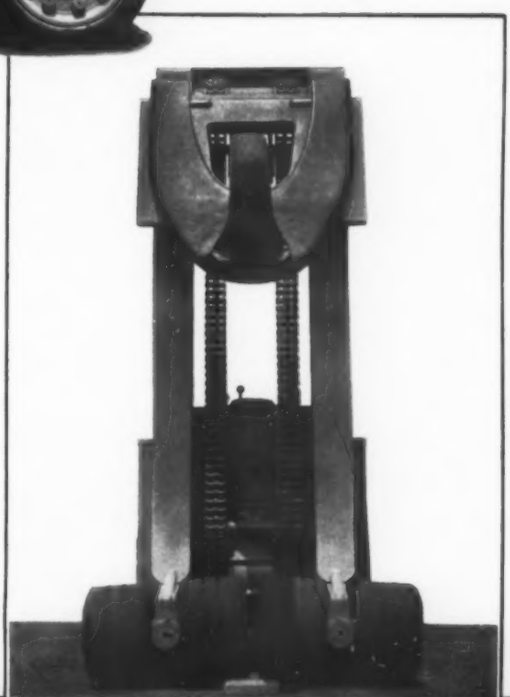
Materials handling in the steel industry has gone through a major evolution in the last five years—Particularly in the new continuous mills. A few years ago 6,000 lb. coils were standard. Today, 25,000 lb. coils have to be coped with.

Progress on this scale has called for corresponding progress from equipment manufacturers. Yale's latest contribution is a fleet of giant 25,000 lb. cap. Ram Trucks recently delivered to one of the country's leading mills. Built to handle huge coils—these trucks feature many mechanical advances, some of which follow.

Time Delay Control in conjunction with exclusive Yale Cam-O-Tactor controls speed in correct intervals one step at a time. This cushions driving mechanism—decreases strain . . . increases truck life.

Hypoid Spur Geared Drive—No steering knuckles . . . fifth wheel rotating construction—Flame hardened gear teeth—Controlled articulating load wheels—Unit welded steel frame with 1½ inch thick steel side members—56 inches of load rubber—Yale Electric Steer (follow through type)—Lifting chains with ultimate strength of 210,000 lbs. . . . All are included on these trucks.

For as Steel progresses . . . so progresses Yale.



THE YALE & TOWNE MANUFACTURING COMPANY

PHILADELPHIA DIVISION • PHILADELPHIA, PA., U. S. A.

MANUFACTURERS OF ELECTRIC INDUSTRIAL TRUCKS • ELECTRIC HOISTS • CHAIN BLOCKS AND HAND LIFT TRUCKS IN ALL CAPACITIES

HOMESTEAD VALVES

PROTECTED SEAT HYDRAULIC OPERATING

HOMESTEAD
Protected Seat

The original and only genuine Protected Seat. It's patented! Assures extra long service; quick, accurate control; low maintenance.

You Profit Three Ways - - - -

When you use Homestead Protected Seat Operating Valves, you profit three ways. ● You eliminate costly shut-downs. ● You reduce maintenance costs to a minimum. ● You increase production and decrease product spoilage, through their greater ease of operation and accuracy of control. The Protected Seat is the key to the long, low-cost, continuous service which you get from Homestead Operating Valves. It stops fluid flow before the seat and disc make contact, thus preventing wire-drawing of the seat, and making possible the established records of 12 to 18 months continuous service without even the replacement of a fibre disc. Thousands of Homestead Operating Valves are used by steel mills throughout the world to control hydraulic presses, furnace doors, manipulators, soaking pit covers, shears, ingot strippers, wire reels, loopers, roll balance, dampers, descaling systems, etc. It will pay you to consult our engineers on your next operating valve needs. No obligation. Write for Valve Reference Book 38, or ask for your copy at Booth 101, Iron & Steel Exposition.

HOMESTEAD VALVE MFG. CO., P. O. BOX 21, CORAOPOLIS, PA.

HOMESTEAD VALVES

QUARTER-TURN VALVES:
STRAIGHT-WAY
THREE-WAY
FOUR-WAY
LUBRICATED TYPE
LIFT-TYPE PLUG

PROTECTED-SEAT VALVES:
HYDRAULIC (B. & O. PAT.) OPERATING
REMOTE CONTROL
HYDRAULIC DESCALING
ROSS AIR SHUT-OFF VALVES
HOVALCO BLOW-OFF VALVES

CHOSEN FOR THEIR *Outstanding* PERFORMANCE AND ECONOMY

Bantam 4 Row Tapered Roller Bearing such as used in the Bliss temper mills. 18" x 30" x 20¾"

THE extensive use of Bantam Bearings in the great modern steel plants is due to their outstanding performance in heavy duty service over a period of many years.

Bantam Bearings have earned a great and growing preference throughout the steel industry because records show that BANTAMS *do* contribute to lower costs per ton of steel rolled.

Such records are the inevitable result of BANTAM'S standardization on highest quality materials, skilled craftsmanship and precision processes. *BANTAM makes all major types of bearings* in a wide range of sizes and invites your inquiries on any and every bearing problem.

BOOTHS 99 AND 100

•

IRON AND STEEL EXPOSITION SEPT. 26-29

BANTAM BEARINGS CORPORATION

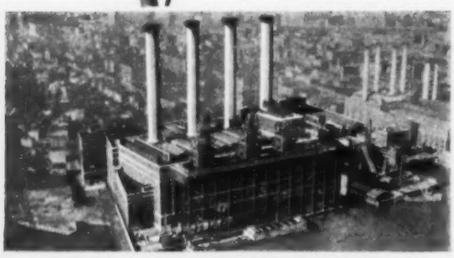
SOUTH BEND, INDIANA

Subsidiary of THE TORRINGTON CO., Torrington, Conn.

BANTAM BEARINGS

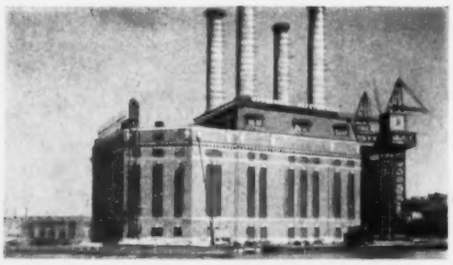
TAPERED ROLLER • • • STRAIGHT ROLLER • • • BALL BEARINGS

SERVING 227

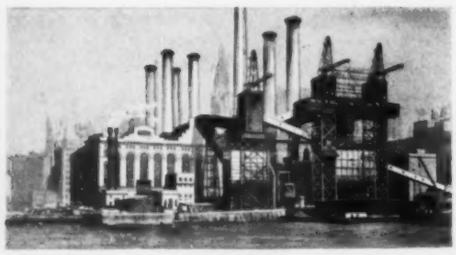


Hudson Avenue Station—Brooklyn Edison Co.
Generator Capacity—770,000 K.W.
Served by—47 Sturtevant Draft Fans

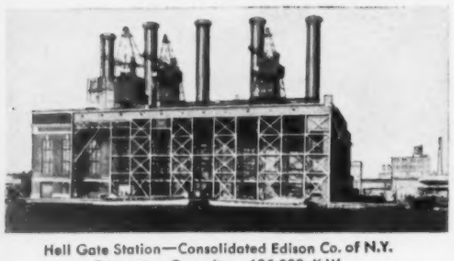
East River Station—Consolidated Edison Co. of N.Y.
Generator Capacity—280,000 K.W.
Served by—33 Sturtevant Draft Fans



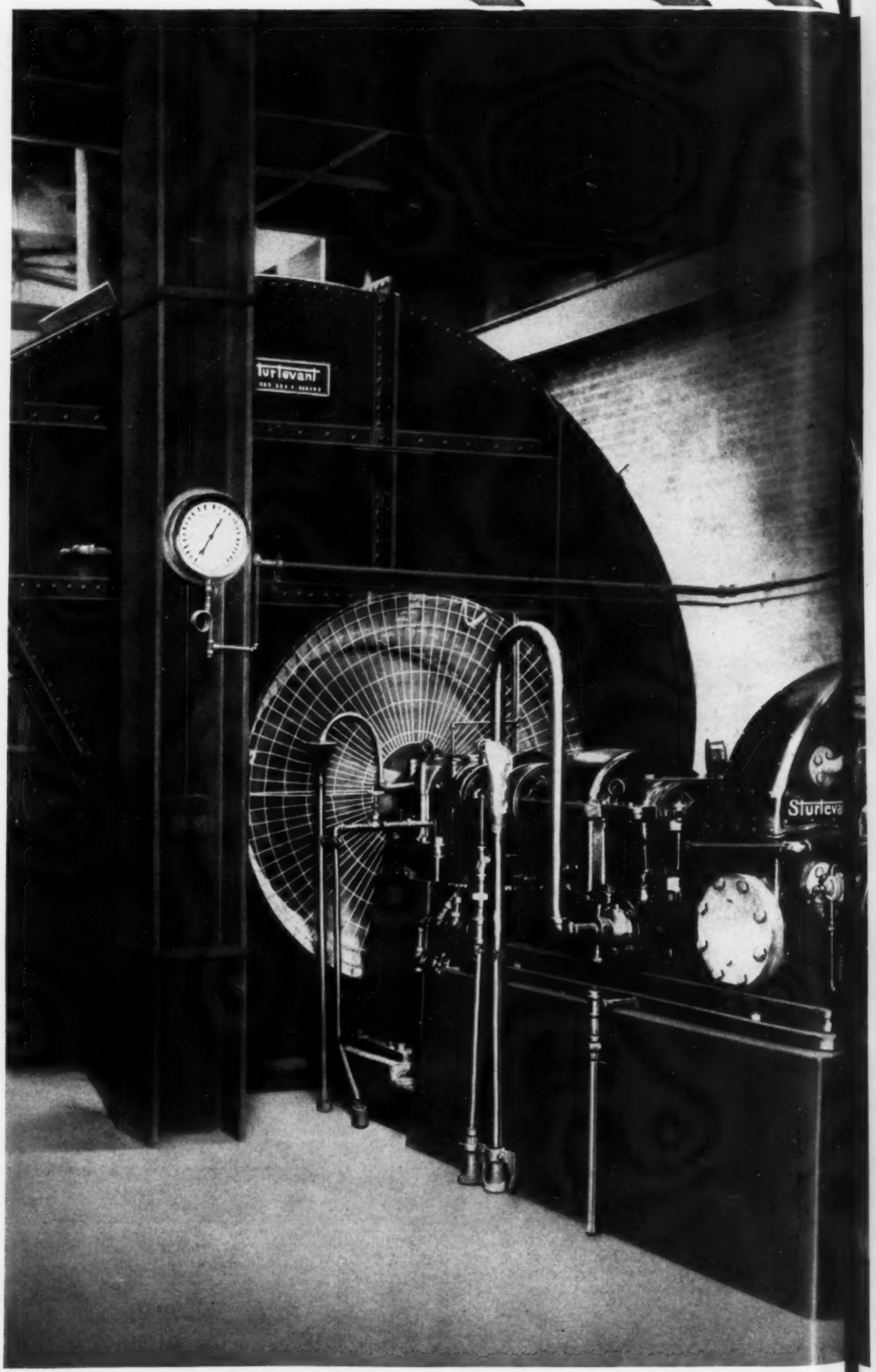
Sherman Creek Station—Consolidated Edison Co. of N.Y.
Generator Capacity—171,000 K.W.
Served by—16 Sturtevant Draft Fans



Waterside Station—Consolidated Edison Co. of N.Y.
Generator Capacity—445,000 K.W.
Served by—23 Sturtevant Draft Fans



Hell Gate Station—Consolidated Edison Co. of N.Y.
Generator Capacity—605,000 K.W.
Served by—41 Sturtevant Draft Fans



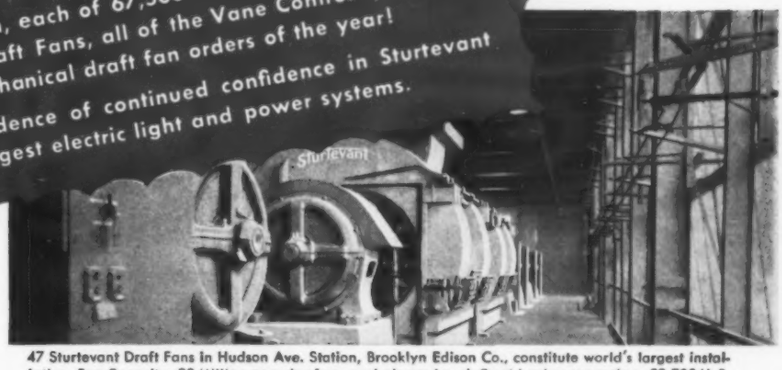
1,080,000 K.W. Generator Capacity WITH MECHANICAL DRAFT!

CORRECTION!

Since this advertisement was first published in July, Sturtevant Mechanical Draft Fans have again been selected by the engineers of Consolidated Edison Company of New York.

To serve two new generators for Waterside Station, each of 67,500 kw capacity, eight Sturtevant Forced Draft and four Sturtevant Induced Draft Fans, all of the Vane Control type, have been ordered . . . comprising one of the largest mechanical draft fan orders of the year!

Sturtevant is proud and appreciative of this evidence of continued confidence in Sturtevant Equipment, on the part of one of the country's largest electric light and power systems.



47 Sturtevant Draft Fans in Hudson Ave. Station, Brooklyn Edison Co., constitute world's largest installation. Fan Capacity: 22 Million pounds of gas and air per hour! Combined motor rating: 28,700 H. P. Induced Draft Fans above. Forced Draft Fan below.

160 STURTEVANT FANS

in stations of

Consolidated Edison Co. of N.Y.

Brooklyn Edison Co.

★

TERRITORY SERVED

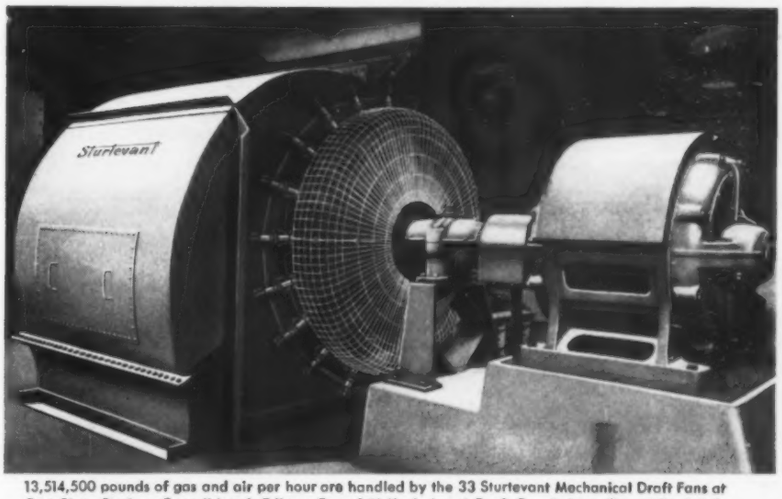
the entire City of New York, world's largest city

POPULATION

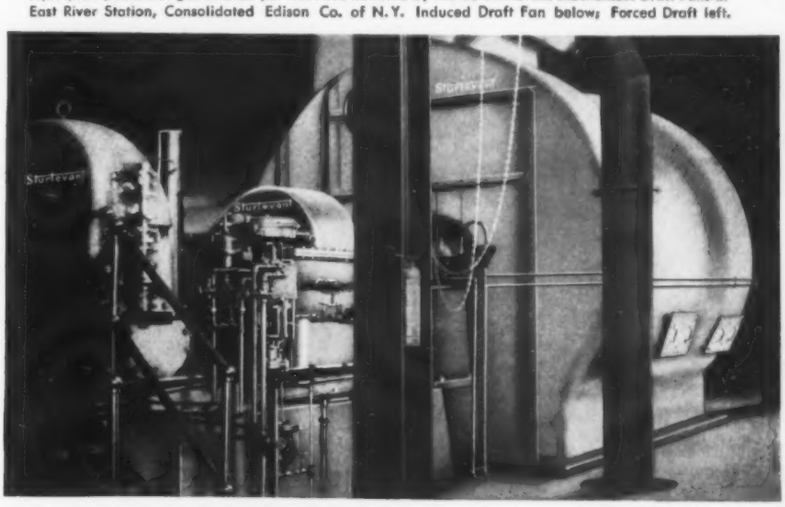
over 7,000,000 people

TOTAL GENERATOR CAPACITY

2,271,000 K.W.



13,514,500 pounds of gas and air per hour are handled by the 33 Sturtevant Mechanical Draft Fans at East River Station, Consolidated Edison Co. of N.Y. Induced Draft Fan below; Forced Draft left.



B. F. Sturtevant Co., Hyde Park, Boston, Mass.

Branch Offices in 40 Other Cities

B. F. Sturtevant Co. of Canada, Ltd.— Galt, Toronto, Montreal

Sturtevant

REG. U.S. PAT. OFF.

Puts Air to Work

(Licensees of both the Van Tongeren and Allardice systems of dust collection.)

DRAFT FANS • TURBINES • GEARS • ECONOMIZERS • AIR HEATERS

This Furnace

is Bright Annealing

High Carbon Alloy Seamless Steel Tubing for Golf Shafts . . . 2000 lbs. per hour

High Carbon Seamless Steel Tubing for Golf Shafts—at the rate of 2000 lbs. per hour—is bright annealed, uniformly, and continuously in the continuous controlled atmosphere furnace installation shown above. This furnace—which is entirely automatic in operation and control—will handle tubing in any desired diameter or length—at any specified temperature from 1250 degrees F. to 1750 degrees F.

Golf shafts, which are made of fairly high carbon alloy seamless steel tubing, must be annealed repeatedly during preliminary operations. The annealing process is very exacting—non decarb is very essential as any decarburization of the thin sections at this point would be cumulative and might spoil a large number of shafts. A uniform and bright anneal is also necessary. The shafts are highly polished before the rigid final inspection. The above E. F. Furnace produces the desired results.

Submit your furnace problems to E. F. engineers. With over 20 years furnace building experience—with hundreds of successful installations operating on practically every heating and heat treating process, and with both electric and fuel divisions, we are in position to analyze any furnace or heat treating problem, give an unbiased report and recommend the best size and type for the specific problem.

Send for printed matter showing other installations for bright annealing, copper brazing, scale-free heat treating, nitriding or any other process in which you are interested.

The ELECTRIC FURNACE Co.

ELECTRIC & FUEL FIRED Furnaces

SALEM, OHIO

L&N CONTROL ON ONE O.H. SOON JUSTIFIES IT ON ALL

Approximately 75 open-hearth furnaces are now being reversed automatically, most of them by the temperature-difference method. Although we could point to the savings which these users report...to the improvement in their operating efficiency...to the very small maintenance required...even more significant is the record of additional installations in a given shop.

One company, for example, placed an O.H. under L&N Automatic Reversal Control in 1931... studied the results. In 1936 (when funds for new equipment again became available) automatic reversal was extended to three more furnaces... early in 1937, to another...and late in 1937, to nine additional open-hearths.

In another shop, the first installation was made in 1934, with control extended to a second furnace in 1935, and to two more units in 1936.

A third shop initially installed automatic reversal in 1931...added two installations in 1932, two more in 1933, and still another in 1938.

Repetition of orders for L&N Roof Temperature Control is just as common. One superintendent, for instance, ordered 20 controls after a trial installation.

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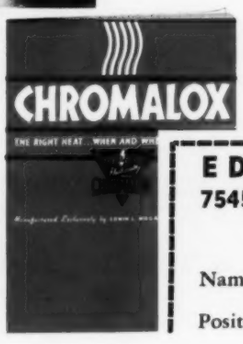

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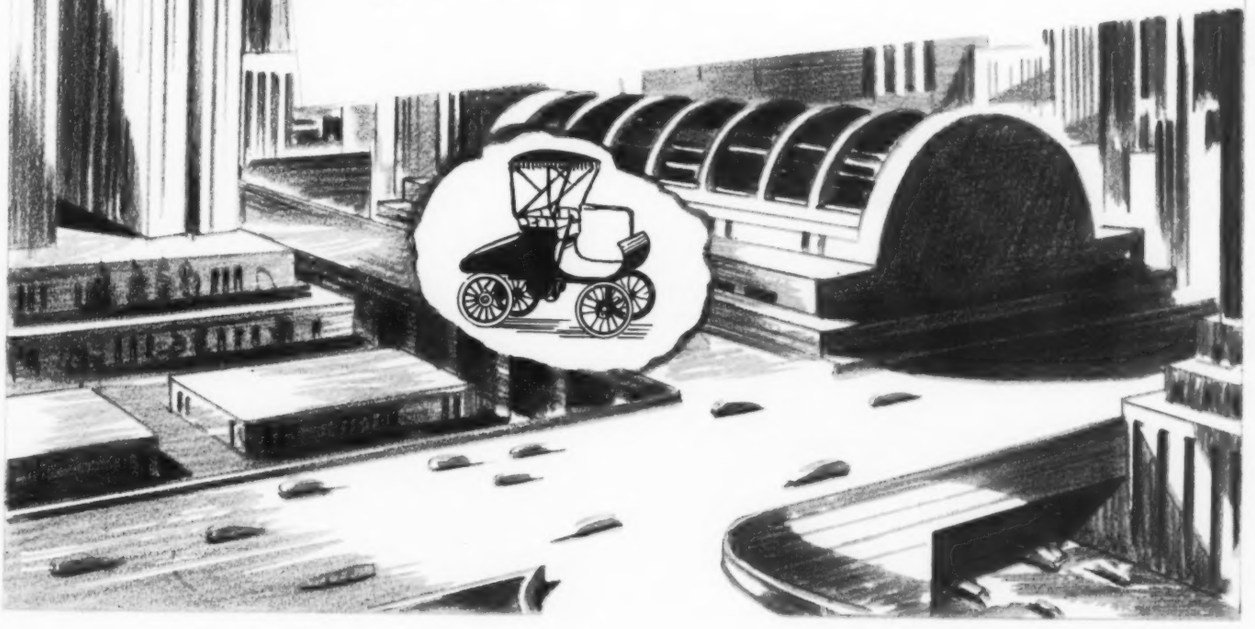


Hardness TESTING of Light Gauge SHEET STEEL by Scratch Resistance

A thesis prepared by JAMES A. TOWNSEND in connection with a graduate scholarship at Alabama Polytechnic Institute. This scholarship is one of two forming the first educational program of the Birmingham Section of the Association of Iron and Steel Engineers.

▲ THIS investigation into the hardness testing of light gauge sheet metal was made in connection with a scholarship given by the Association of Iron and Steel Engineers, and under the local sponsorship of the Birmingham Section of this Society. It was one of a list of ten subjects which were suggested as material for study, and was selected from the list because it was the one thought most suitable with the facilities available at the Alabama Polytechnic Institute.

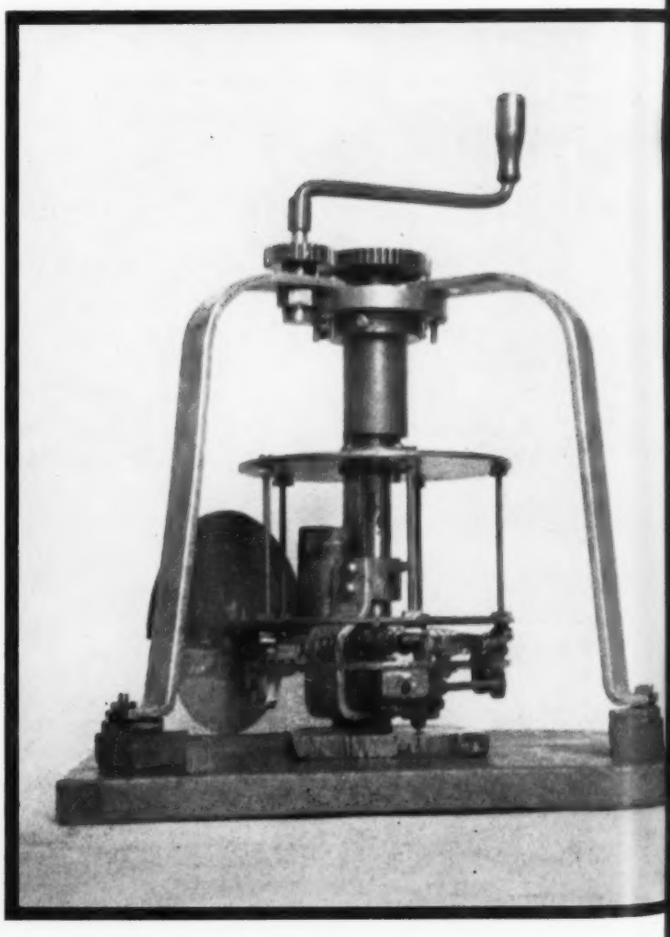
Methods of commercial hardness testing today are without exception comparative methods, and are used in determining the suitability of materials for definite purposes in comparison with a material having a degree of "hardness" that has been found satisfactory in practice. The machines which measure comparative hardness in terms of an arbitrary scale of numbers do not measure the true or absolute hardness of the material being tested, because of the fact that the significance of "absolute hardness" has not yet been determined. In this investigation the primary purpose has not been to look into the theoretical side of the question, but merely to attempt to develop another method of determining comparative hardness values. However, it is hoped that some light may be thrown on the nature of what the term "hardness" really means, as a result of this work.

In the investigation a scratch method for measuring the hardness of sheet metal was employed because of the limitation of the present Rockwell machine, the superficial hardness tester, used in production testing in most tin plate mills. It was felt that a scratch method of some kind might be the answer to the problem of error due to anvil reaction in the Rockwell test. Any other penetration method now in use is also subject to such errors in results whenever the sample becomes so thin that the amount of penetration into the metal is effected by the reaction of the support or anvil upon which the sample rests. Thus far, no Rockwell type of machine has been developed with weights light enough to eliminate faulty readings.

In beginning the work it was realized that the successful determination of a new procedure would mean a great deal of time, probably more than would be available in one college year. However, the work was begun in the hope that during the course of the year enough data would be obtained to indicate the reasons for the success or failure of the apparatus.

The problem was sharply limited by the basic requirement that a new method should employ a machine which could be used in production work—a machine which would be quick-acting and direct-reading. An apparatus such as the Bierbaum "Microcharacter" (1), which is suitable for use in the laboratory, would not suit the requirement because of the length of time necessary to obtain results. Because of this need, any method in which a microscope must be used for meas-

FIGURE 1—View of sclerometer showing scratch point in contact with plate.



uring the width of the scratch, such as is used with Bierbaum's instrument, or in which exceptionally careful and delicate adjustments must be made, was necessarily eliminated. After a good deal of consideration, it was decided to attempt the measurement of the turning moment exerted by a scratching point which would be driven in a circular path in contact with the sheet to be tested. With the machine in its present form (Figures 1 and 2), a two and three-sixteenths inch diameter circle is described by the scratching point, which is held in a chuck pivoted to the bottom ring of the machine. In making a test, the handle was turned slowly, actuating the revolving cage through the gear and pinion, and drawing the point over the sample. The cutting action of the point exerted a turning moment on the ring. This torque was then resisted by the five coil springs which connected the two rings. The springs were compressed slightly, the relative movement actuating the gear train on the dial by means of a rack on the lower ring. Variable weights were at first tried directly on the scratching point, but since space was found to be lacking for sufficient force to be applied in this manner, a lever was built which increased the effect of the weights. Changes were also made in the size of the springs until satisfactory readings could be obtained over the range of Rockwell hardness values used. Needle bearings were used to keep the lower ring centered. Two shapes of scratching points were tried. The first of these was similar to that used in Graton's sclerometer (1) and shaped like the curved nibs of a ruling pen. The other was made in the form of the corner of an imaginary cube, after Bierbaum's method, and was used in the later trials. Both points were made of high speed tool steel.

The control samples consisted of steel plates, five inches square and one-half inch thick. They contained about 0.20 per cent carbon, and were heat-treated to produce a range of Rockwell hardness values from B-64 to B-98. The usual range of such values for tin plate is from B-40 to B-86, but it was found impossible to reduce the lower limit of the range below B-64 by any annealing treatment. However, some samples of the actual uncoated tin plate were secured later, and the Rockwell value supplied with them extended the lower extremity to B-52. This range was found sufficient for partially determining the capabilities of the scratch resistance method.

The investigation of hardness testing by resistance measurement was based primarily on the evidence given by S. R. Williams (1) leading to the conclusion that the scratch method is a variation of the penetration method when no material is abraded or torn away from the test

FIGURE 2—View of sclerometer showing resistance indicating dial.

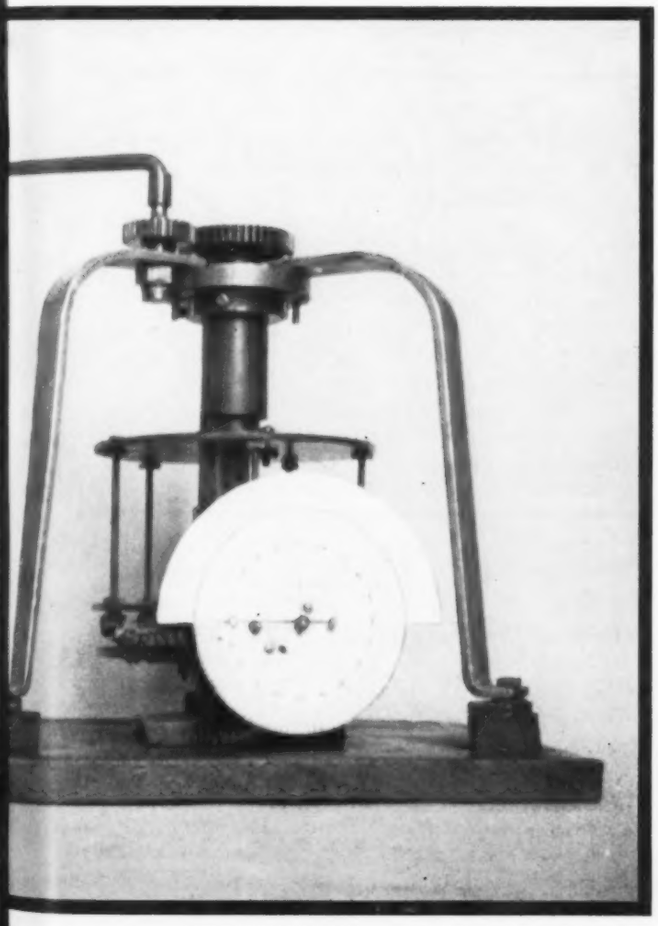
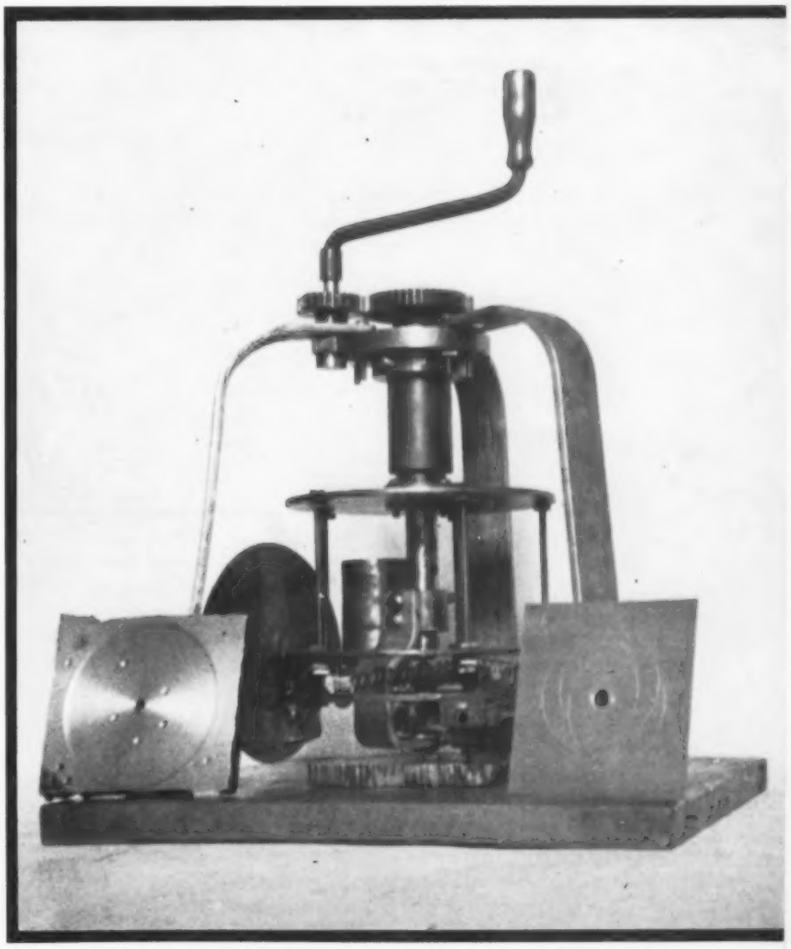


FIGURE 3—View showing plate and sheet samples with circular scratch paths.



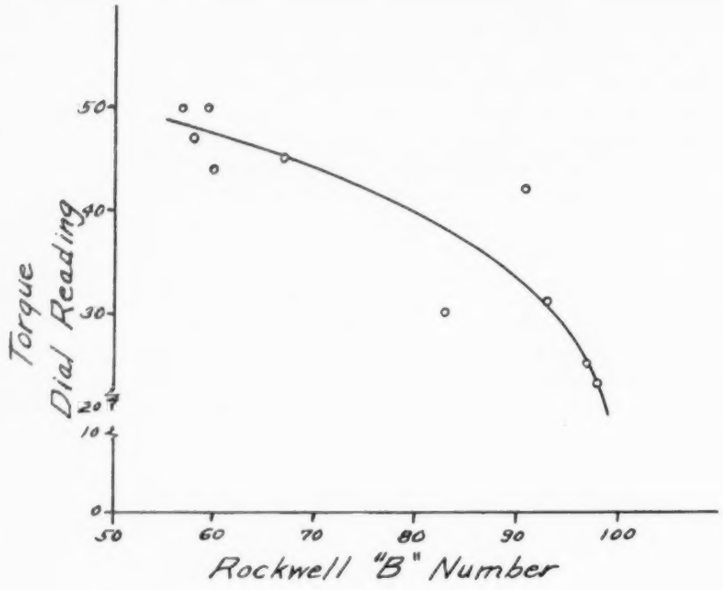


FIGURE 4—Typical trend curve for cubic tool at an angle of 35 degrees with plate sample. (left)

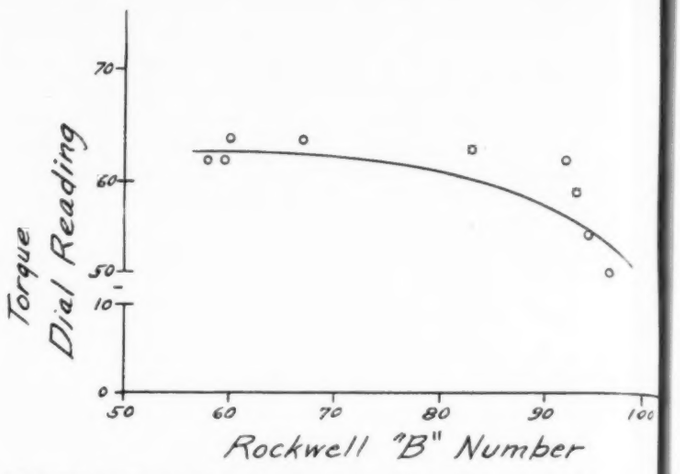


FIGURE 5—Typical trend curve for cubic tool at an angle of 25 degrees with plate sample.

TABLE I

Sclerometer dial readings and direct Rockwell "B" numbers for thick plate samples and 35 degree cubic tool.

Order of Increasing Hardness	Rockwell "B" Number	Dial Reading	Sample Number
1	57	50	XI
2	58	47	XII
3	59	50	IX
4	60	44	II
5	67	45	VII
6	83	30	V
7	91	42	VIII
8	93	22	VI
9	93	40	IV
10	97	25	X
11	98	23	I

TABLE II

Sclerometer dial readings and direct Rockwell "B" numbers for thick plate samples and 25 degree cubic tool.

Order of Increasing Hardness	Rockwell "B" Number	Dial Reading	Sample Number	Scratch Width (mm)
1	58.0	62	XII	0.175
2	59.5	62	IX	0.165
3	60.0	64	II	0.165
4	67.0	64	VII	0.160
5	83.0	63	V	0.150
6	92.0	62	VIII	0.135
7	93.0	59	IV	0.120
8	94.0	55	VI	0.160
9	96.0	51	I	0.125

specimen; that is, when the deformation due to the scratching tool is plastic. If this hypothesis were true, a measure of the resistance to scratch displacement of the metal should give some relation between the resistance values and the Rockwell penetration numbers.

Other methods of scratch hardness testing have been largely concerned with laboratory work with minerals. The method of Talmage and Graton (1) employs a diamond point loaded with small adjustable weights and drawn over the specimen. The width of the cut is then compared under the microscope with a standard scratch. This apparatus and that devised by Bierbaum for metals are the two most important recent developments, but as before stated, are useful only in the laboratory.

DATA AND RESULTS

The actual work consisted of making a series of tests on control samples, each of which had been treated to a certain hardness as measured by the Brinell machine and converted into Rockwell "B" numbers. These values were later checked on an actual Rockwell machine. The apparatus, scratch point and weights, was turned one complete revolution on the control sample. Since the dial reading varied during the revolution, an average was taken of the readings during each third of a complete turn, the dial indication remaining fairly constant in each third. Many mechanical difficulties arose in the making of the tests, and much of the time

available was devoted to improvements and additions to the apparatus.

In preparing the control samples from one-half inch steel plate containing about 0.20 per cent carbon, it was found impossible to produce a smooth surface on them by polishing with emery without producing a surface hardening effect due to cold working. In one case, a sample was hardened from 163 Brinnell to 177 by such a polishing operation. Because of this effect, a tool finish was used that was as fine as could be obtained. It reduced the surface hardening, but left much to be desired in the refinement of the surface.

It was also found necessary to take the Brinell readings immediately after the sclerometer readings, at least for the first three or four weeks after the heat treating of the samples, in order to avoid an increase in hardness due to aging. One sample increased in Brinell hardness from 163 to 207 in three weeks, after being quenched in water from 1320 degrees Fahrenheit. Others age-hardened in a similar manner.

The Rockwell "B" numbers for the plates were, as before stated, first found by converting from the Brinell readings, but were later checked and found to be somewhat in error. The maximum difference found was 14 per cent, while the average error was about 4 or 5 per cent, which was in accordance with general practice in making this conversion (1).

During the course of the work three sets of springs were tried, and various weights applied to the scratch point before a combination was found that gave results which were at all satisfactory. The springs used in the later tests had a resistance of 10 pounds per inch each, and were attached between the rings at a radial distance from the center of the rings of 3 inches. The lever arrangement which applied the load to the scratch point originally magnified the effect of the weights in the ratio of 5 to 1, but this value was later changed to 3 to 1. The actual force acting on the scratch point was then five pounds.

The resistance offered to the point, and the depth it entered into the metal were dependent to some extent on the mechanical errors in the construction of the apparatus. That is, the scratch point consistently scratched deeper, and the dial reading was correspondingly higher in one section of the circle described by the point. This variation was allowed for in the averaging of the readings, for each third of a complete revolution. Some of the variance in the dial readings was due to slight play in the scratch point chuck bearing. The point would be drawn slightly out of a true circular path, then would abruptly come back into line. This fault was later almost entirely corrected.

In any further improvement in the apparatus the tool should be made from a diamond, and shaped with a cubic corner as in Bierbaum's instrument. In using the tool steel scratch point a limited number of samples were included in the range of hardness values, so that, for each run, the dulling of the point had no appreciable effect.

Figure 4 shows the data and curve for a typical run with the plate samples, the angle of incidence of the cubic tool being 35 degrees. Figure 5 gives similar data for any angle of 25 degrees, while Figures 6 and 7 show the data for the tests on thin sheets. As can be seen, the readings were quite erratic around the lower and

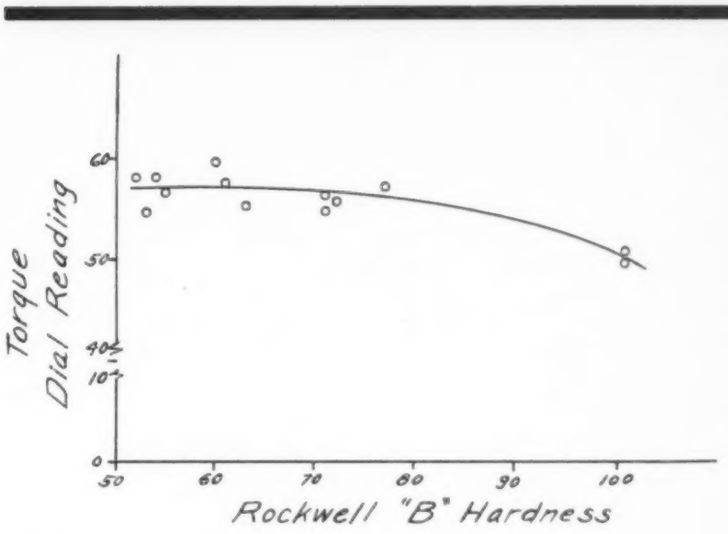


FIGURE 6—Curve showing typical trend for cubic tool at an angle of 25 degrees with sheet sample.

TABLE III

Sclerometer dial readings and corresponding Rockwell "B" hardness values for light gauge sheets amples and 25 degree cubic tool.

Order of Increasing Hardness	Rockwell "B" Number	Dial Reading	Sample Number	Gauge	Scratch Width (mm)
1	52	59	11	34	0.175
2	53	55	5	28	0.200
3	53	61	9	32	0.195
4	54	59	7	30	0.180
5	55	57	1	20	0.150
6	60	60	12	34	0.180
7	61	58	8	30	0.175
8	63	56	3	26	0.190
9	71	55	4	26	0.180
10	71	57	6	28	0.185
11	72	56	13	24	0.170
12	77	58	10	32	0.180
13	103	51	2	20	0.110

middle sections of the hardness range, decreasing rapidly only when the hardness values were comparatively high. Although the curves do not show a gradual decrease in dial readings, or torque values, for a gradual increase in Rockwell hardness numbers, they do indicate a consistently lower torque for the high hardnesses. The trend of the plotted values indicates the possibility of a definite relation between the scratch resistance and the Rockwell numbers, were the apparatus sufficiently refined to record it. The higher angle of incidence of 35 degrees between the edge of the cubic tool and the sample gives a greater difference in dial readings, as

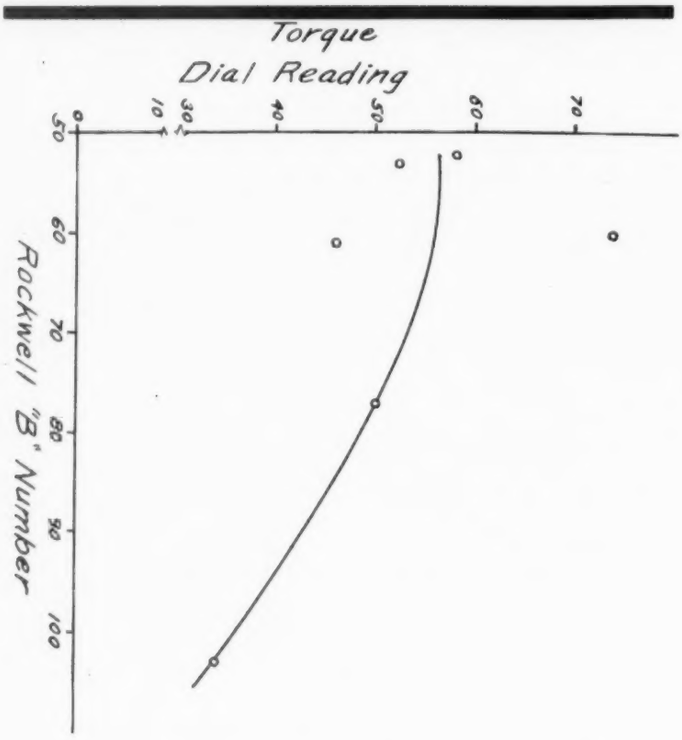


FIGURE 7—Curve showing typical trend for cubic tool at an angle of 35 degrees with sheet sample.

TABLE IV

Sclerometer dial readings and corresponding Rockwell "B" hardness values for light gauge sheet samples and 35 degree cubic tool.

Order of Increasing Hardness	Rockwell "B" Number	Dial Reading	Sample Number	Gauge
1	52	58	11	34
2	53	53	9	32
3	60	74	12	34
4	61	46	8	30
5	77	50	10	32
6	103	34	2	20

shown in the curves, for the range of sample hardnesses. However, the high angle tool caused the dial indicator needle to vibrate excessively, so that readings were difficult to obtain. The 25 degree tool was much smoother in its action, but was less sensitive to changes in hardness numbers. Its smoother action was probably due to a reduction in the horizontal component of the force acting on the needle as it was drawn over the sample.

A comparison of the scratch widths with the Rockwell hardness values, as shown in the data, gives similar results. The widths are not proportional to the comparative softness of the steel in the lower part of the Rockwell range, but they are appreciably smaller in the extreme upper end. From tests on a large variety of steels, Hadfield and Main (2) showed that an empirical relation existed between Brinell numbers (and therefore Rockwell numbers) and scratch widths when the Brinell number did not exceed 600. Hankins (1) worked out a straight line relationship between scratch widths and the diameters of the Brinell ball impressions. From this evidence it may be logically assumed that this scratch resistance method was not in error, but that the erratic values for scratch widths with a constant weight on the point were due to mechanical faults in the machine. Since the scratch widths decreased in magnitude as the resistance values became less, it is entirely possible that in a further investigation the width of scratch may be found to be inversely proportional, in some ratio, to the scratch resistance hardness number.

The inconsistency in readings, and the failure to record differences in hardness may be partly due to the balancing effect of two conditions. In the first place, the softer the metal, the easier the point penetrates. Secondly, the deeper the point goes, the more material there is to be pulled apart or displaced. Hence, a constant weight method of torque measurement not only has to do with the initial penetration of the point, but also with the pushing aside of the grains after the penetration. In the harder substance the penetration is not so great at first, and there is less metal to be displaced, but on the other hand, the displacement is the more difficult because of the inherent cohesive property of the harder material.

In Figure 8 is shown the cross-section of a typical scratch in sheet steel. It is almost identical with the scratch made by Bierbaum's instrument, except that it is much larger. A top view of the scratch is shown in Figure 9. The displacing effect of the cubic point is shown by the ridges along the edge of the scratch. Although the depth of the scratch is only about one-fourth or one-fifth of the total thickness of the sheet, a ridge can be easily seen on the under side of the sample, indicating an anvil reaction. This may be interpreted to mean that the scratch method using a tool with a sharp point, cannot be used, and that some tool with a rounded or spherical shape is needed for further study. Such an interpretation may be taken to mean the absolute failure of this method for testing thin sheets, since it is likely that a spherical point could not be made to penetrate while being drawn over the specimen without

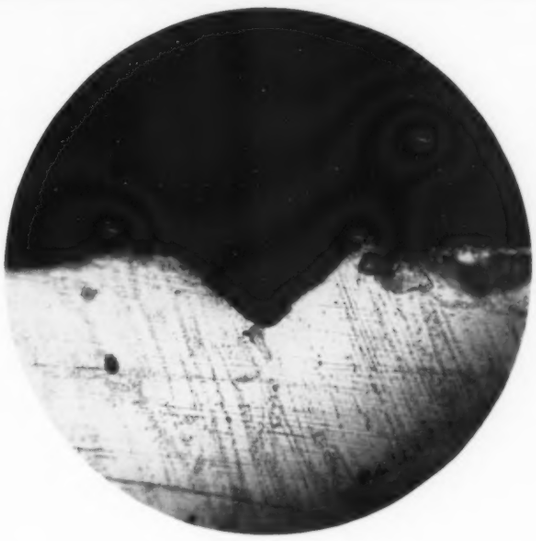


FIGURE 8—Cross sectional view of typical scratch made by cubic tool in sheet steel. x 350.

employing weights as heavy as those found in the indentation methods now in use.

CONCLUSION

The test results were sufficient to show a definite trend towards lower torque resistance values for higher hardness numbers, B-90 to B-100 Rockwell, as compared with a greater resistance to scratch penetration in the softer samples using a constant weight. This trend points toward a definite relation between the scratch penetration and direct indentation methods of comparative hardness measurements.

As far as the avoidance of anvil reaction is concerned, the scratch method did not perform as it was hoped that it might. A scratching point with a wider, more rounded shape should be tried before the project is rejected as unworkable.

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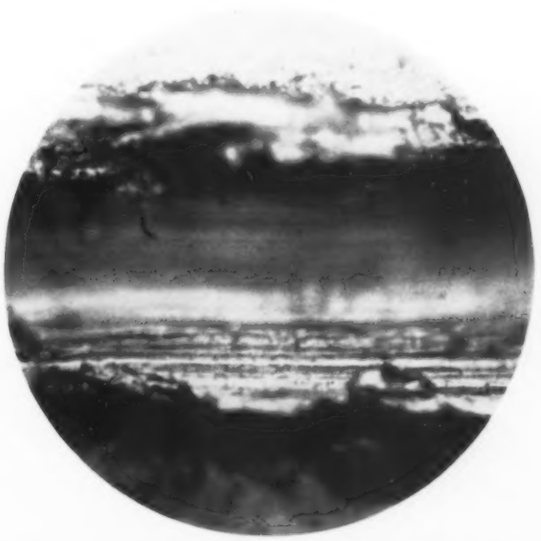


FIGURE 9—Top view of typical scratch made by a cubic tool in sheet steel. x 350.

DESIGN and U
GEARS and I

CLARK JOHNSON, *Manager,*

Gear Department

United Engineering & Foundry Co.

PITTSBURGH, PENNSYLVANIA

▲ THE modern steel plant of today is vastly different than that of a comparatively short time ago due to the great variety of types of equipment used in transforming materials into salable products. New gear applications have developed likewise, as investigation shows that nearly every piece of equipment required in steel mill work incorporates the use of gearing. The steel mill engineer of today, therefore, must by necessity spend most of his time studying the operation and results of equipment, leaving little time to investigate subjects such as the detailed design of a gear train best suited for a given application, and it is the object of this paper to discuss in general some of these details.

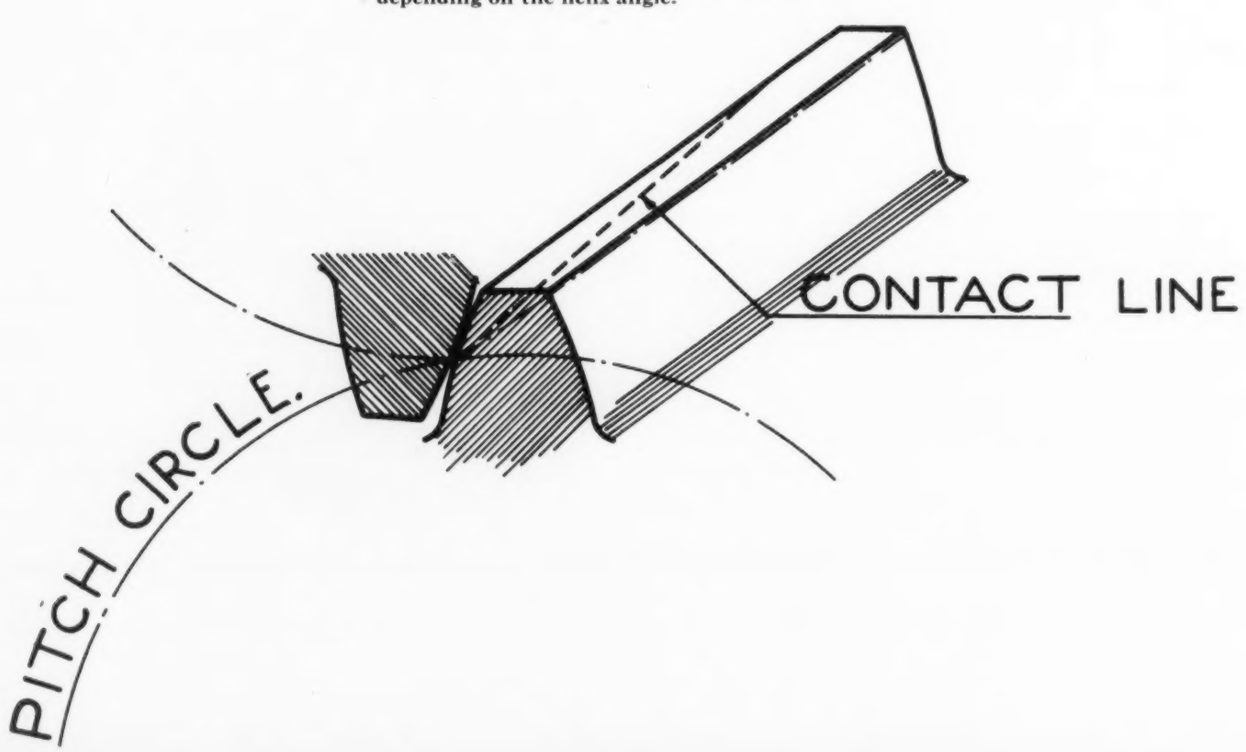
REQUIRED CAPACITY OF THE GEARS IN QUESTION

The first and one of the most important steps in designing a train of gears is to determine the loads to be transmitted. By the accumulation of data and exchange of experience by its members, the American Gear Manufacturer's Association has done noble work in standardizing the capacities of small standard gear units. The selection of such units by these standards is to be dependent upon, among other things, the actual loads to be transmitted and a service factor depending on the nature of the loads. More often, however, the gear manufacturer on receiving an inquiry is not given the entire story and must select the size of the unit based on the motor speed and its rated horsepower, the gear ratio and the type of equipment to be driven.

A mill is usually designed to roll a certain product or products at a given speed, and quite often provisions are made to roll different products at a future date, which may call for a change in power requirements, in which case due consideration should be given to the load-carrying capacity of the driving gears from the standpoint of future use, as well as present.

In certain types of shears the amount of work done in cutting the material is not a direct indication of the size of the driving gears required, since a greater part of the energy expended for the cutting operation comes from the kinetic energy of the moving masses of the shear proper and is not instantaneously transmitted through the gearing. For reasons such as these the mill builder has a decided advantage in determining the loads which must be transmitted through the driving gears because of familiarity with the work done and

FIGURE 1—The load on helical gearing is along a straight line extending diagonally up the tooth, the inclination depending on the helix angle.



...and LUBRICATION of ...and PINIONS

Presented before the A. I. & S. E.
Annual Convention, Cleveland, O.,
September 27, 28, 29, 30, 1938

the inherent characteristics of the machine doing the work.

SELECTION OF THE TYPE OF GEAR TO BE USED

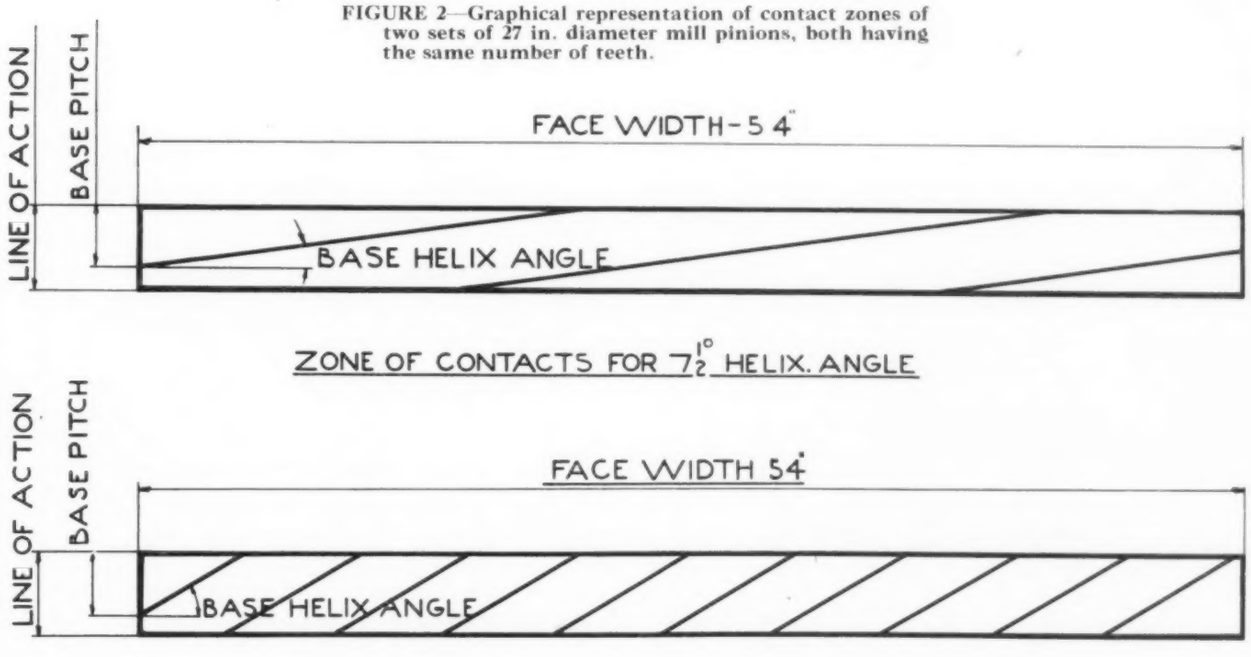
For parallel axes three types of gears are used; namely straight tooth, single helical and herringbone.

The load as applied to a straight tooth spur gear is effective on a line parallel to its axis. During the various phases of tooth engagement the number of teeth in contact varies, causing unequal loading on various parts of the tooth surface resulting in uneven wear and thus destroying the contour of the teeth. Destroying the shape of the teeth will, of course, make it impossible for the gear to transmit uniform angular motion, and if the pitch line speeds are of any consequence, the dynamic loads may be increased to the point where noise and vibration become objectionable. However, in certain instances the general design of a machine may necessitate the use of straight tooth gears, particularly from the standpoint of assembly.

Helical gears may be considered as an infinite number of straight tooth gears having infinitely small face widths so arranged that the teeth trace the helix. The load, therefore, as applied to a helical gear will be along a straight line extending diagonally up the tooth, the amount of inclination depending on the helix angle as shown in Figure 1. Since the contact lines extend across the face of the gear from the roots to the tips so that at no time is there a sudden transfer of load from one tooth to another, helical gears therefore tend to wear more evenly than straight tooth gears and will continue to transmit uniform angular motion even after considerable wear has taken place. The multiplicity of teeth in contact will therefore reduce dynamic loads and render smooth and quiet operation. To obtain satisfactory overlaps of tooth contact in the axial plane it is often necessary to use a high helix angle.

Figure 2 shows two rectangles representing the contact zones of two sets of 27 in. diameter mill pinions; one having a 7½ degree helix angle, the other a 30 degree helix angle, and both having the same number of teeth. The diagonal lines represent the lines of contact across the face and the total length of these lines

FIGURE 2—Graphical representation of contact zones of two sets of 27 in. diameter mill pinions, both having the same number of teeth.



represents the total length of contacts. Investigation shows that the pinions with 30 degree helix angle have approximately fourteen per cent greater total contact than those having 7½ degree helix angle. The use of single helical gears with high helix angle may, on certain designs, prove to be a disadvantage since the amount of end thrust due to tooth loads is directly proportional to the angle. In most cases, however, it is possible to simplify the design by the use of herringbone gears, wherein the end thrust from opposing teeth would be neutralized.

One still hears debated the relative merits of single helical and herringbone gears. There is no doubt but that each has its place, and in its place one has distinct advantages over the other.

Figure 3 shows a double reduction gear drive in which spiral bevel gears are used for the primary reduction and single helical gears for the secondary. The spiral bevel gears must be mounted so that both gear and pinion shaft can be moved endwise to adjust for proper tooth engagement. If in this instance herringbone gears were used for a secondary set great care would be necessary in assembly to insure proper contact on both sides of the apices of the gear teeth, and most likely proper tooth contact could not be maintained in operation because of shaft expansion caused by temperature changes.

Figure 4 shows a single reduction unit with an idler gear mounted in roller bearings. Due to the light bearing loads and for economical reasons, single row bearings are used. Because of the arrangement of the bearings, all shafts must be held from moving in an endwise direction and it can readily be seen that single helical gears have a distinct advantage over herringbone gears for this application.

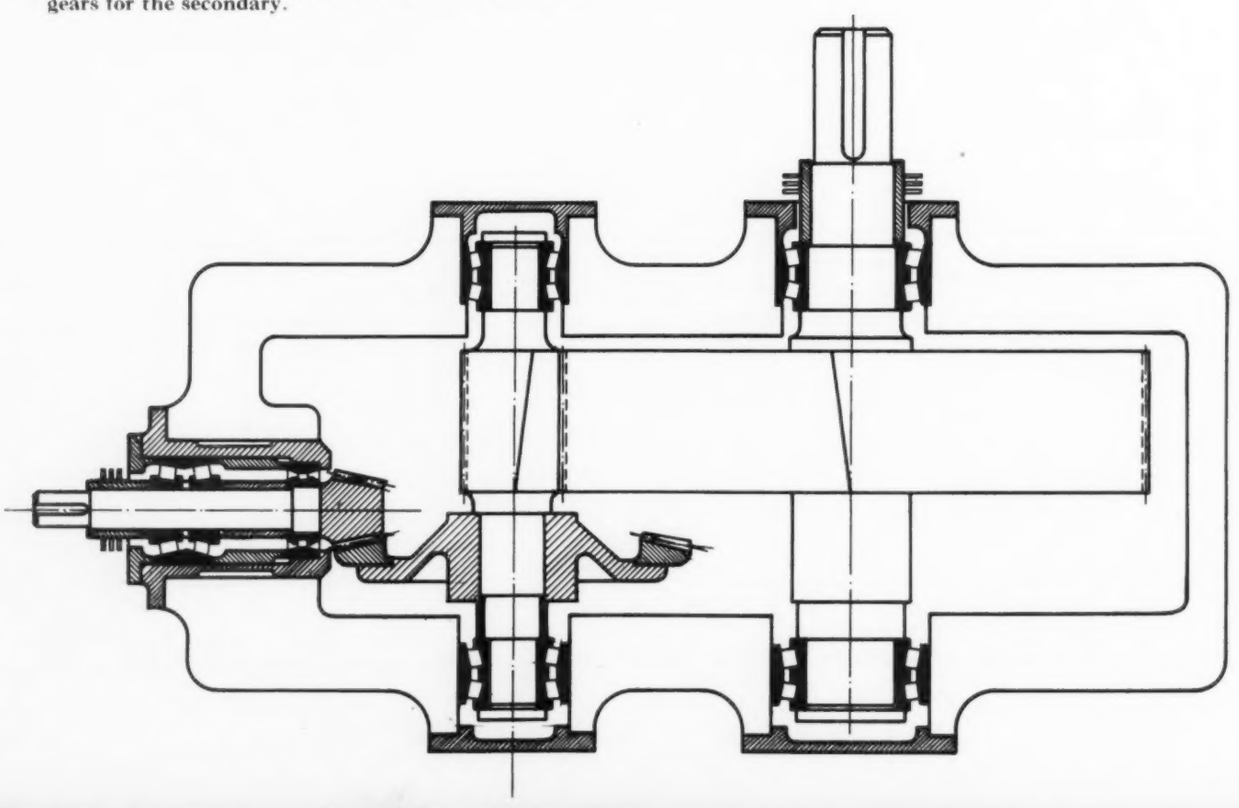
Figure 5 shows a similar drive with herringbone teeth. In this arrangement one bearing is held to position the gear train, while the other bearings are allowed to float so that proper tooth engagement takes place. With this arrangement the bearings used are somewhat more expensive than the single row bearings shown in the previous figure. The same general methods of shaft mounting could be employed should babbitted bearings be used.

In the design of pinion stands the advantages of herringbone teeth over single helical teeth are often debated. In this respect there is no reason why a pinion stand should not be regarded as an ordinary reduction unit. It is desirable to use a comparatively high helix angle to obtain multiple tooth contact and at the same time minimize end thrust from the tooth loads. The herringbone pinion serves these requirements. With herringbone mill pinions there should be no external thrust loads imposed on the driving or driven shaft extensions so as to cause unbalanced loads on the two halves of the pinion faces. As a rule on modern mills flexible couplings and universal couplings are used on the driving and driven shaft extensions respectively, making external end thrust negligible.

On many old installations the well-known "loose coupling boxes" were used in connecting the pinion stand to the mill or to the driving unit. After the equipment had operated for some time the flutes in the coupling box and the wobbler ends would become worn and rounded on the corners, thereby tending to separate the driving or driven members from the pinion shafts and causing one pinion to be shifted endwise with respect to its mate. With this condition present it is apparent that single helical pinions would be the more satisfactory.

Because of the popularity of herringbone gears as applied to steel mill drives, a few illustrations will be shown to describe in general the methods of mounting. Figure 6 shows a single reduction unit with babbitted bearings, in which the gear shaft is positioned by means of thrust collars at one bearing. No thrust collars are

FIGURE 3—Double reduction gear in which spiral bevel gears are used for primary reduction, and single helical gears for the secondary.



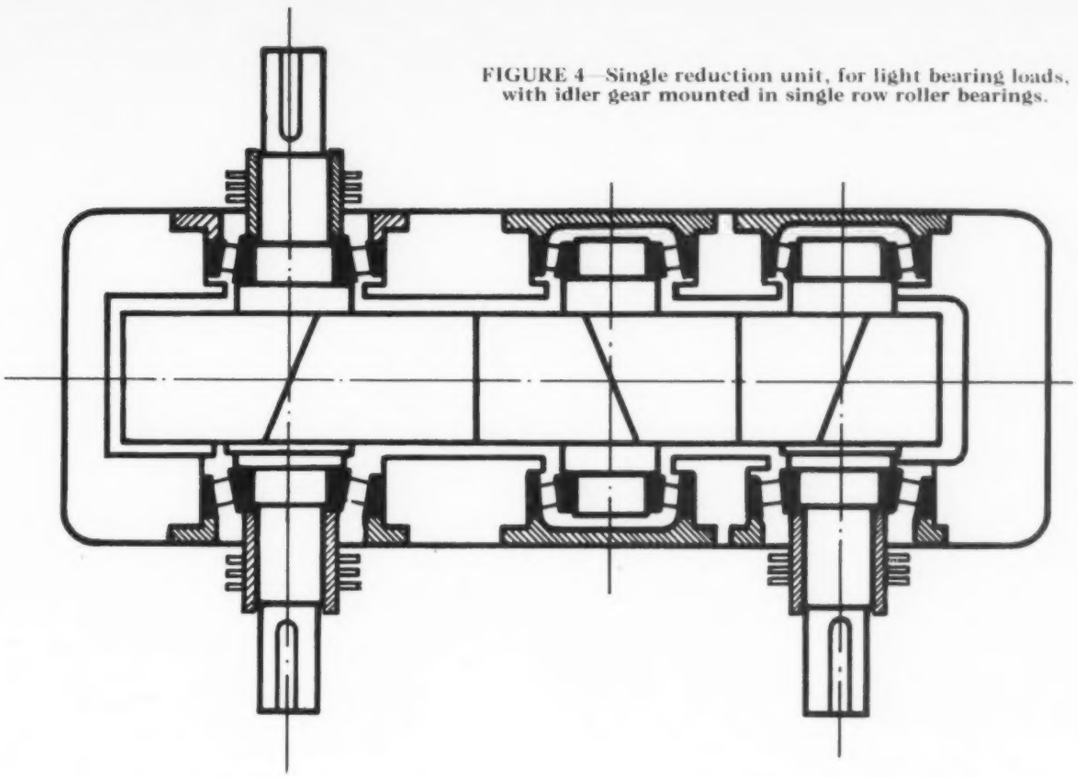


FIGURE 4—Single reduction unit, for light bearing loads, with idler gear mounted in single row roller bearings.

used on the pinion bearings, thus allowing the pinion to center itself with respect to its mating gear. A similar design is shown by Figure 7 except that roller bearings are employed. Here again, one bearing positions the gear train.

After fulfilling the speed requirements and determining the amount of load to be transmitted, as well as selecting the material and type of gear to be used, the physical proportions of the gears can be determined. At the outset, the sizes are usually selected based on past experience, after which selection various conditions must be investigated, such as the best conditions for proper tooth contacts; the relation of face widths to diameters, shaft deflections, etc. As a rule the load-carrying capacity of a gear train is established from the standpoint of wear, but the beam strength of the teeth must not be overlooked. There are certain gear applications in steel mill work where the tooth proportions must be selected from the standpoint of resistance to breakage, as well as resistance to wear.

Various formulae are used by various manufacturers for determining the load-carrying capacity of a given train of gears, a comparison of which may give varying results. However, various service factors, or as described by some engineers "factors of ignorance" are used in connection with the different formulae so that the ultimate results regarding physical proportions selected for a given requirement are as a rule approximately the same.

To apply any of the various formulae is a comparatively easy matter, but the selection of the proper service factor, or determining the load for which the gears are to be designed, requires more good judgment.

Gear steels and their heat treatment have, in recent years, received considerable attention and much has been done to investigate the characteristics of the different types commonly used. This subject has been a more important problem to the automobile manufacturer than to the manufacturers of industrial gears, because of consideration to weight and available space requirements.

Tests on different varieties of accepted gear steels, when given the proper heat treatment, show little difference regarding resistance to fatigue. With the various types of steels used, it is a generally known fact that a definite relation exists between hardness and ultimate strength and, for this reason, hardness within certain limits is regarded as a determining factor with respect to fatigue resistance.

Gears and pinions of large proportions such as are commonly used in steel mill applications usually receive their heat treatment before machining. The resultant hardness must therefore be controlled so that the material will be commercially machinable. Good finish is also important on gear teeth and if the material is too hard, it becomes difficult to obtain smooth surfaces.

In gear train the pinion should always be harder than the gear to give added strength to the pinion, and to prevent the possibility of the seizing of contacting surfaces. The gear tooth surface will, in operation, become work hardened. An interesting case in this respect was the recent checking of a pair of mill pinions which had been in service for a number of years. The pinions were made of .40 carbon cast steel and the original hardness was probably in the neighborhood of 200 Brinell. The hardness test made on the wearing surfaces after years of service showed the hardness to be 365 Brinell.

Considerable study has in recent years been given to heat treatment of gear teeth to obtain extremely hard tooth surfaces for the purposes of increasing their load-carrying capacity. Greatest effort has been along the line of surface, or torch hardening, where localized heating and cooling are used to obtain high hardness.

While the method is old, the usefulness of this process is still debatable, as apparently it has not proven itself where extremely high tooth loads are encountered. A great number of gears hardened in this manner have given years of satisfactory service, but have to the writer's knowledge, operated under moderate tooth loads, in which case softer gears no doubt would have given equally good results. To successfully transmit heavy loads gear teeth hardened in this manner must have sufficient and uniform case depth and the inner softer core must be sufficiently strong to prevent excess deflection to eliminate any possibility of the development of surface cracks in the hardened zone.

To obtain sufficient case depth, care must be taken to prevent overheating the material. The one favorable characteristic of this method of heat treatment is the absence of appreciable distortion. Recent machines have been constructed for the torch hardening of gear teeth, the principle purpose of which is to control the many variables which either make for the success or failure of the process. It is hoped that gears hardened on such equipment will, in the near future, have been subjected to service which will definitely prove whether or not the process is a commercial advantage.

Carburizing is also used quite extensively for obtaining high surface hardness. Unfortunately, this method of treatment is accompanied by appreciable distortion and therefore the physical properties and shapes of gears conveniently treated in this manner are limited. The teeth of small gears produced on mass production basis are sometimes ground after hardening, but so far this practice has not because of economical reasons become feasible for the manufacture of industrial gearing. Also on large industrial gears with large tooth proportions great depth of case is desirable for carrying heavy loads. To obtain a hardened case of $\frac{1}{16}$ in. depth requires a heating time of approximately 8 hours, while 75 hours are required for a depth of $\frac{3}{16}$ in. It is therefore apparent that the furnace costs become quite high for this method of hardening.

The so-called "soft gears", or those hardened before final machining, will have under load a greater tendency to correct mechanical discrepancies than will gears of extremely hard tooth surfaces.

DESIGN AND WORKMANSHIP

In designing a drive, careful consideration must be given the gear case, as well as the gears proper. The gear case should have reasonable rigidity and the pinion shaft and gear shaft should be of sufficient diameters with respect to their length to avoid excess deflection.

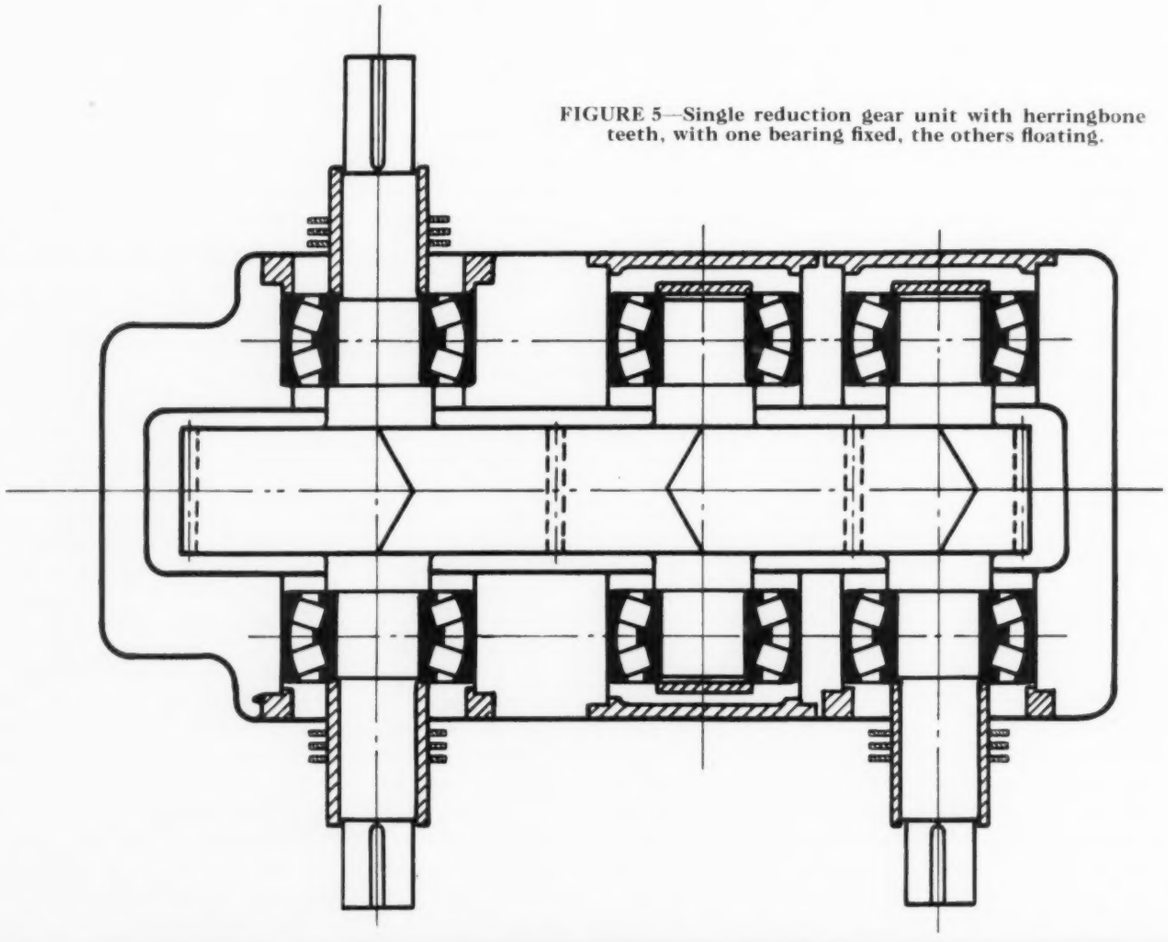


FIGURE 5—Single reduction gear unit with herringbone teeth, with one bearing fixed, the others floating.

Proper bearing sizes and mountings are very important as it is necessary that these parts keep the gears in their proper location at all times. In order to give greater assurance that the gear will run true with the axis of its supporting shaft, it is wherever possible, desirable to design the shaft so that the gear may be cut when mounted thereon.

Good shop practice goes hand in hand with good design and the manufacture of successful gears and gear drive. Adequate equipment for cutting a given set of gears is of most importance. Quite often large gears are cut on machines which are too light for the work, resulting in deflections and vibrations of the machine parts, with consequent unsatisfactory results. For good results the machine and the cutting tools must be kept in good condition and experienced operators must be available to run the equipment. The revolving elements must be properly balanced. Gears cut on certain types of machines must be balanced before cutting to obtain good results.

OPERATION

Quietness in operation is a definite characteristic of a well designed and properly manufactured gear set. For this reason all gear drives should be given a running test on completion of manufacture. No standard measuring stick has been set up for industrial gearing to establish whether a gear set is noisy or quiet and it is therefore a matter of individual opinion.

Gear noises in general may be caused by faulty design or workmanship, improper lubrication and variations in transmitted or applied loads. However, a gear set which may have been judged as quiet in shop tests may prove to be noisy in operation, and the reason for such variation in performance can usually be determined.

The writer had an interesting experience in this respect a few years ago. A large double reduction mill drive had just been placed in service on a hot strip mill. The high speed gears consisted of two opposing single helical sets, since overhung fly wheels were used. The low speed gears were of herringbone type and the entire gear train positioned by one bearing on the low speed shaft. On being placed in service the drive was noisy, but not to the point of being objectionable, and as operation continued the difference in quietness of operation of the drive in question, with respect to other drives nearby, prompted an investigation. Inspection of the gear teeth on both high and low speed sets showed good bearing contacts and actual measurements indicated that all gears were positioned for proper tooth engagement. After considerable effort, it was found on removing one of the high speed bearing caps that the cap had been pinching the outer race of the roller bearing, thereby preventing the gears from finding their exact centers under load. On providing clearance between the outer race of the bearing and the bearing cap, the drive became exceedingly quiet in operation.

GEAR TOOTH FAILURES

Gear tooth failures are encountered in the form of tooth breakage or surface failures. With the use of helical gears, tooth breakage is rare and surface failures, therefore, receive most attention. Surface failures occur in the form of wear, pitting, spalling or deformation in the shape of the teeth.

Excessive tooth wear is usually caused by excessive tooth loads or improper lubrication. The cause of pitting of gear teeth has for many years been the subject of much study and investigation and, to the writer's knowledge, has never been definitely determined.

Dr. Stewart Way in his paper "Roller Tests to Determine Pitting Fatigue Strength" reports some very interesting findings resulting from experiments carried out in the laboratories. In these experiments sets of rollers were run together under load to produce pitting, and, as outlined by Dr. Way, it was found that pitting resulted from the formation and growth of cracks in the material; that the resistance to pitting increased with increased hardness in material; that lubrication affected pitting in that any change in the viscosity of the lubricant up to 2000 seconds Saybolt universal showed no effect, but with use of heavier lubricant the resistance to pitting increased; that rollers run without any lubricant would not pit, but with the addition of a lubricant after the rollers had been run dry, pitting developed at a rapid rate: that the use of extreme pressure lubricants had no effect as compared with ordinary lubricants with respect to resistance to pitting.

Since the tests as discussed applied only to rollers, it is yet to be ascertained just to what extent the findings can be applied to gears, since, in the action of gearing there is relative sliding between the tooth surfaces, as well as rolling. However, in general, it is thought that pitting is the result of shearing stresses in the material.

Spalling is similar to pitting, and different from it in that the areas affected are of greater physical proportions. Spalling is quite often found in case hardened steels where the case hardened surface breaks away from the softer core at the line of demarcation.

Deformation in the shape of the teeth may be caused by insufficient lubricant or the complete absence of a lubricant. The defect can, of course be easily controlled. Deformation in the shape of the teeth can also be caused by overloads of sufficient magnitude to stress the material beyond its yield point.

LUBRICATION

The sliding which takes place between mating tooth profiles in operation creates friction and it is the purpose of the lubricant to reduce the amount of friction to as small a degree as possible. When two sliding surfaces are completely separated by a film of oil perfect lubrication exists. When perfect lubrication is obtained the frictional resistance is independent of the pressure between the surfaces and dependent on the viscosity of the lubricant. When sliding surfaces make metal to metal contact, and with no lubricant present, the frictional resistance is proportional to the pressure between the contacting surfaces. High grade bearings are used in which under proper operating conditions perfect lubrication is obtained. To obtain this desirable condition in the operation of gear teeth is very difficult and usually impossible, due to the action of the teeth which tends to wipe off the lubricant and rupture the oil film. It is especially difficult to maintain an oil film where high pressure and low rubbing speed exists. In spur

gears the theoretical tooth contacts are lines, but due to the elasticity of the material, the profiles are deformed resulting in area contacts, and it is logical to assume that with a given unit load and relative rubbing speed, a heavier lubricant will offer more resistance to being forced from mating surfaces than will a lighter one. It is therefore apparent that with a given speed, the viscosity of the lubricant should be increased as the unit loading is increased. However, if too heavy a lubricant is used, excessive heat will be generated due to fluid friction. The selection of a lubricant for a given gear set is therefore a compromise whereby the combination of sliding friction between the mating teeth and the fluid friction of the lubricant is kept at a minimum.

It is interesting to note that oils of different viscosities as tested on well known testing machines, show little or no difference in film strength. It must be remembered that in such tests the conditions approached are more nearly those of perfect lubrication and therefore the results are not directly applicable to gear lubricants.

It is also interesting to note that various types of machines used for testing load-carrying characteristics give varying results with a given lubricant.

A number of extreme pressure lubricants have proven to be superior over straight mineral oils from the standpoint of load-carrying capacity, but care should be used in their selection, as inferior grades may prove less effective than ordinary oil. In inferior grades the compounding agent often separates from the mineral oil to

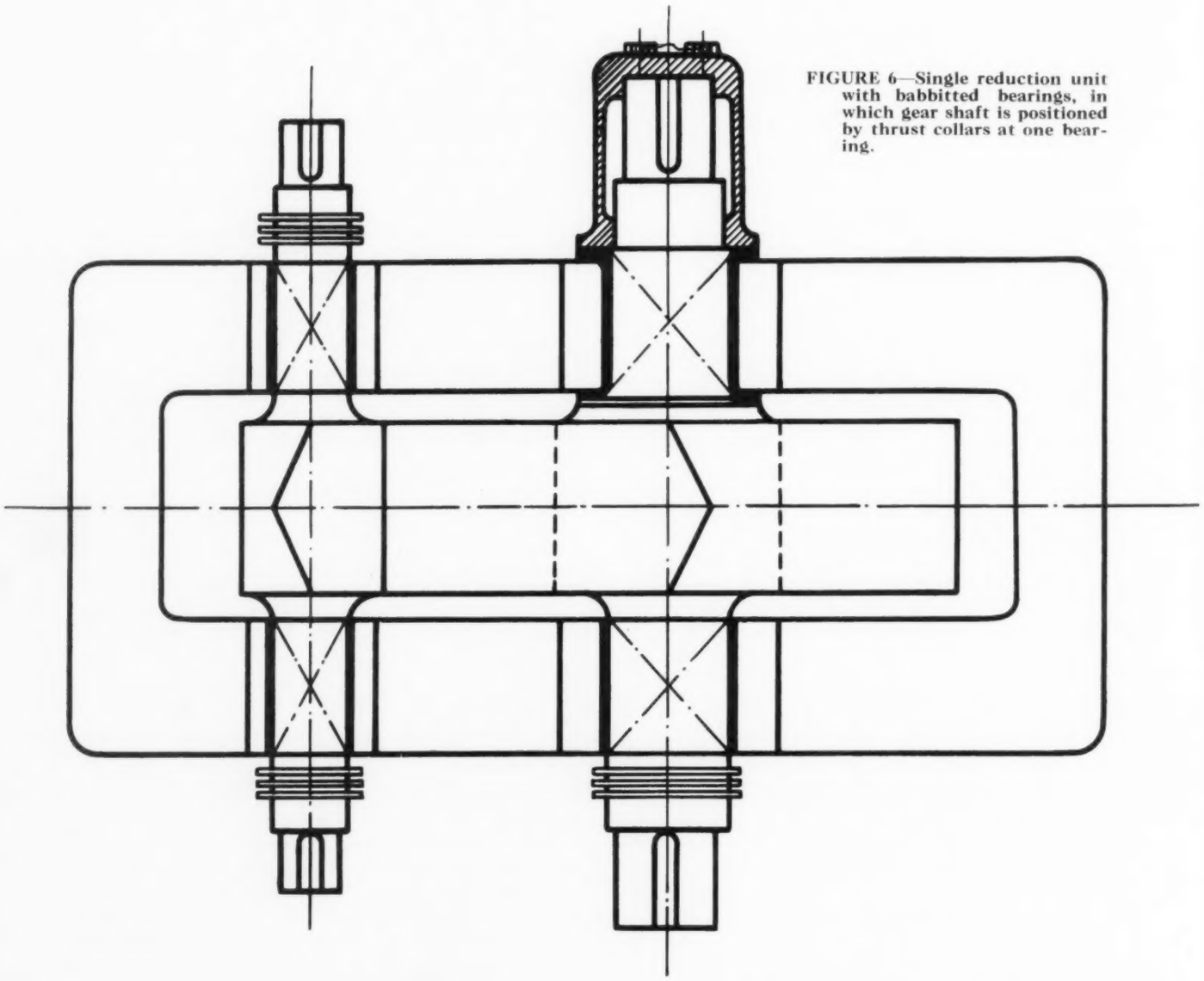


FIGURE 6—Single reduction unit with babbitted bearings, in which gear shaft is positioned by thrust collars at one bearing.

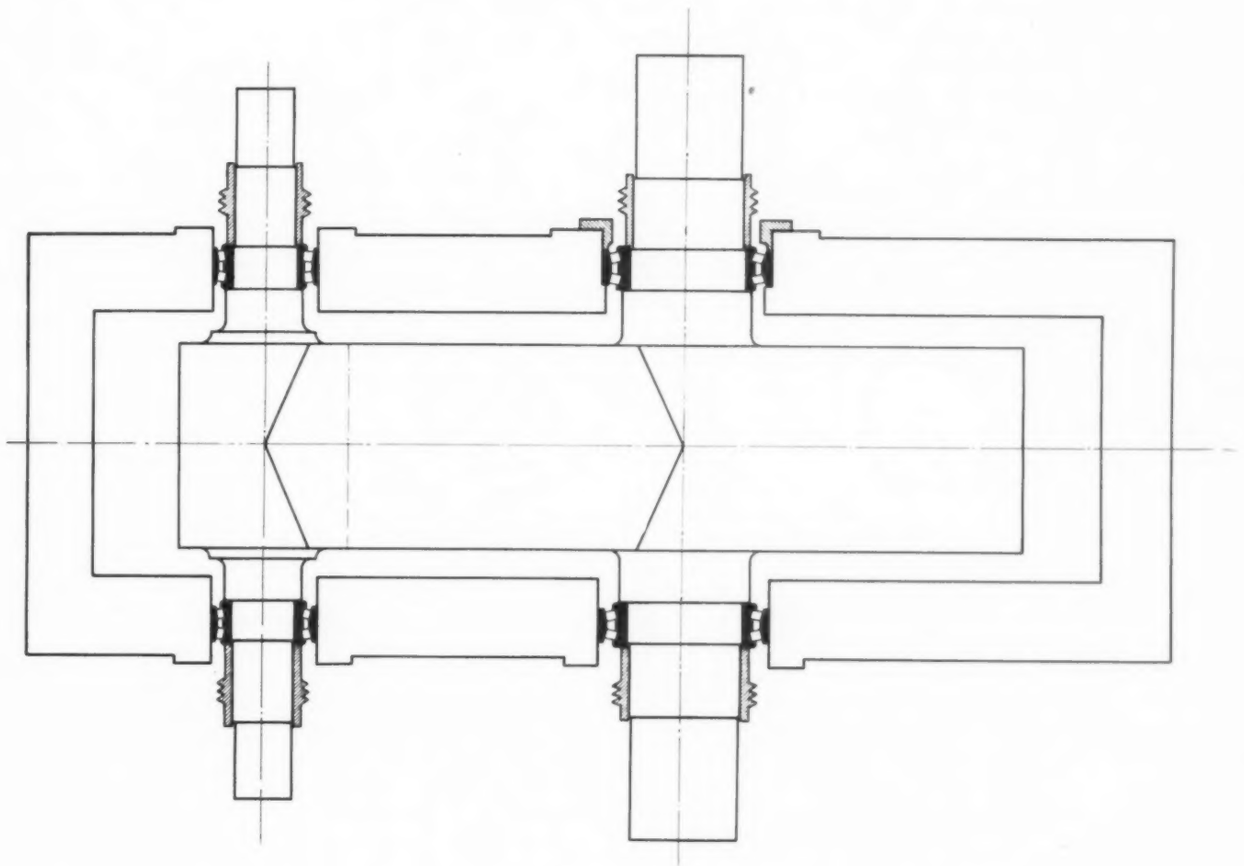
which it has been added, leaving a light bodied oil unsuitable for the intended purpose.

APPLICATION OF LUBRICANT TO GEAR DRIVES

In general, two methods are used in applying lubricants to gears and bearings of modern drives, namely by splash systems and pressure systems. In splash systems the gears dip into the lubricant and a sufficient quantity of the lubricant must be thrown off to lubricate the bearings as well. With such an arrangement the viscosity of the lubricant and the pitch line speed of the gears must be such that excessive heat is not developed. Splash systems in which the quantity of lubricant supplied to the gears is controlled are in satisfactory use, but usually in such cases, individual cooling units must be applied.

With the use of circulating systems, the lubricant is sprayed to the meshing points of the gears and supplied under pressure to the bearings. With such an arrangement the lubricant can easily be filtered to remove any foreign particles which may have been picked up by the lubricant and a storage tank provided of sufficient size to allow the oil to settle out before being returned to the gear case. The storage tank referred to has usually sufficient area so that excessive heat is removed by radiation. With such an arrangement, a cool, clean oil is always available to be circulated to the moving parts.

FIGURE 7—Single reduction gear unit with roller bearings, one of which positions the gear train.



DISCUSSION

PRESENTED BY

F. J. THOMAS, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio.
L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.
F. E. ROSENSTIEHL, Technical and Research Division, Texas Company, New York, New York
A. W. STEED, Superintendent Maintenance, American Rolling Mill Company, Middletown, Ohio.

F. J. THOMAS: I would like to point out the growing tendency to use roller bearings in the mountings of gears and pinions. In my opinion this is proving to be a very good thing and one which allows for simpler and more efficient lubrication of both gears and bearings. Furthermore, I believe the use of this type of bearing will result in longer life for gears and pinions because of the fact that the proper alignment and meshing of the gears is more easily maintained.

Concerning the various types of wear on gears and pinions, a great deal is heard today, possibly because we are beginning to feel that it is not necessary to be wearing out and replacing gears as often as used to be the case. It is my belief that when gears are properly cut and run together in the manufacturer's shop in such a way that the teeth mesh properly and have full tooth contacts both across the tooth and from top to bottom of the tooth, that such things as pitting, spalling, galling and scuffing will be reduced to a minimum. It is also believed that where the loads to be imposed upon gears and pinions are likely to be above normal, the use of the proper types of extreme pressure lubricants is desirable.

Gear cases and pinion housings may and should be designed so that lubricant cannot escape through joints, along shafts or through bearings. It is desirable that more attention be given this feature, for preventing lubricant leakage also prevents the entrance of contaminating elements.

L. F. COFFIN: It is particularly fortunate that the gear designer and the lubrication man thus meet to discuss a common problem. I feel that lubrication and mechanical engineers in the steel industry must continue to urge manufacturers to continually improve the quality of the product they sell us as steel mill equipment. Rapid strides have been and are being made in the last very few years in the manufacture of gears for steel mill drives. Main mill drive pinions, both helical and herringbone, are being satisfactorily manufactured of case hardened steel in sizes up to 24 in. pitch diameter. Such pinions, of course, require grinding and after that, lapping.

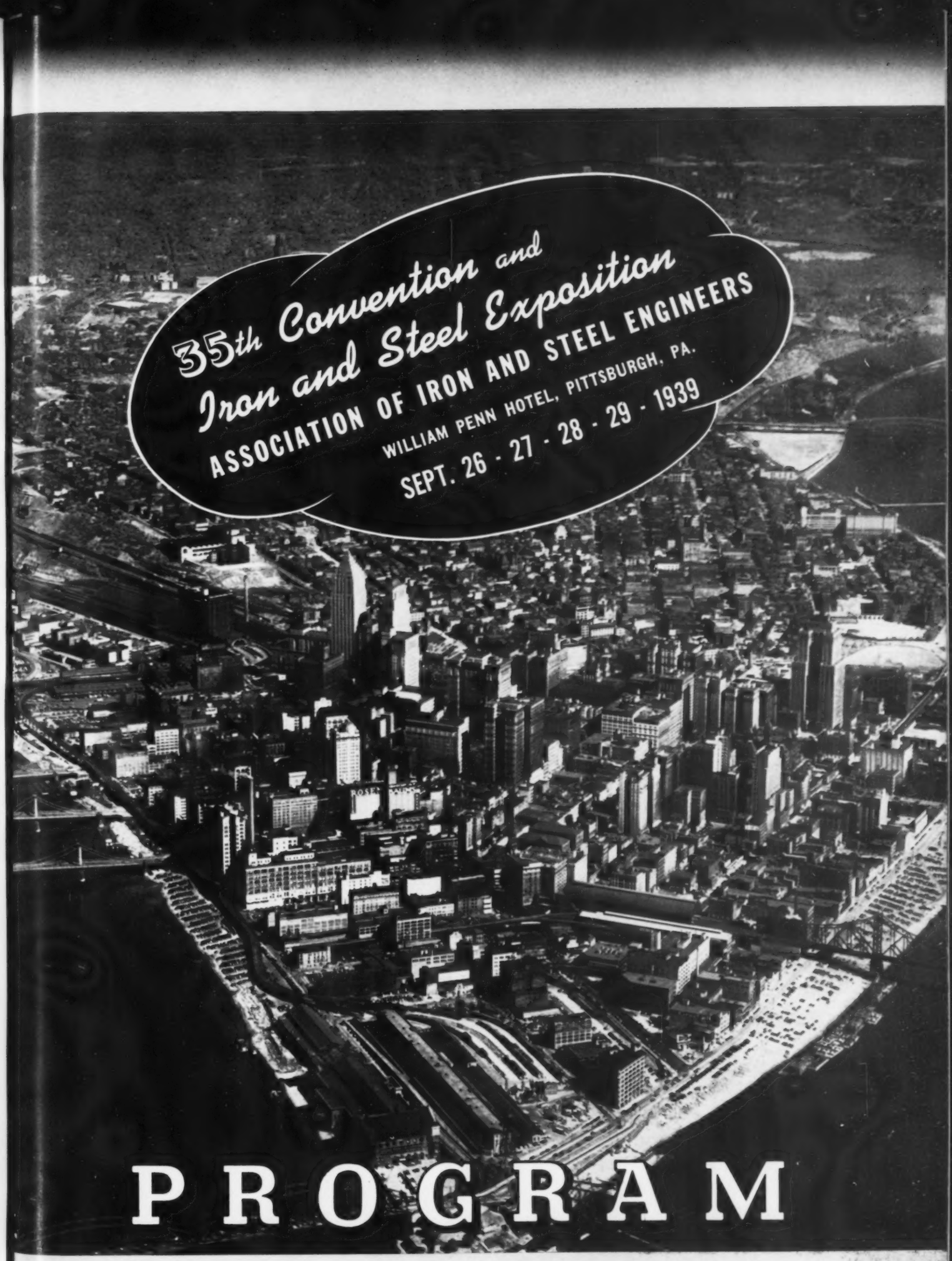
The subject of lapping is a most interesting one and worth taking more time in mill erection or mill repairs than is usually allowed. All manufacturers of many important drives should lap gears in the factory. It has been our practice to do so wherever possible in repair work and in many cases, we have secured additional shutdown time for this purpose. If you can get a full tooth contact between the pinion and gear to start with, your problems of pitting usually disappear, permitting the use of a lighter grade lubricant which is more susceptible to separation of water and oxides. Many cases where this has been applied may be cited, such as staggered cast tooth pinions for 160 in. plate mill drives, 42 in. continuous cold tandem mill drives, tension reel drives, etc. In one case of main motor pinion replacement on a 42 in. 5-stand tandem mill, due to the flame hardened pinion cracking, the replaced pinion was installed, gear case drained and plugged off from the system, the pinion and gear rotated at a low speed and lapped in to a uniform tooth bearing, consuming a total time additional of only 8 hours.

F. E. ROSENSTIEHL: We in the oil industry must, of course, be quite as concerned about the protection of gears in service as the designers and operators. The lubrication engineers regard load condition and the design of the set as being of the utmost importance. These factors virtually dictate when and where to use extreme pressure lubricants. One must, of course, correlate theory with actual service conditions. For example, a gear set may run along satisfactorily with a straight mineral lubricant for a considerable period of time and then suddenly, due to some overload condition, a lubricant of higher film strength has to be used. Such conditions are appreciated by all concerned and I am sure that the steel mill engineers realize that the oil industry has kept pace with the mills' specific requirements and are able to offer a range of lubricants which will meet virtually any condition of operation.

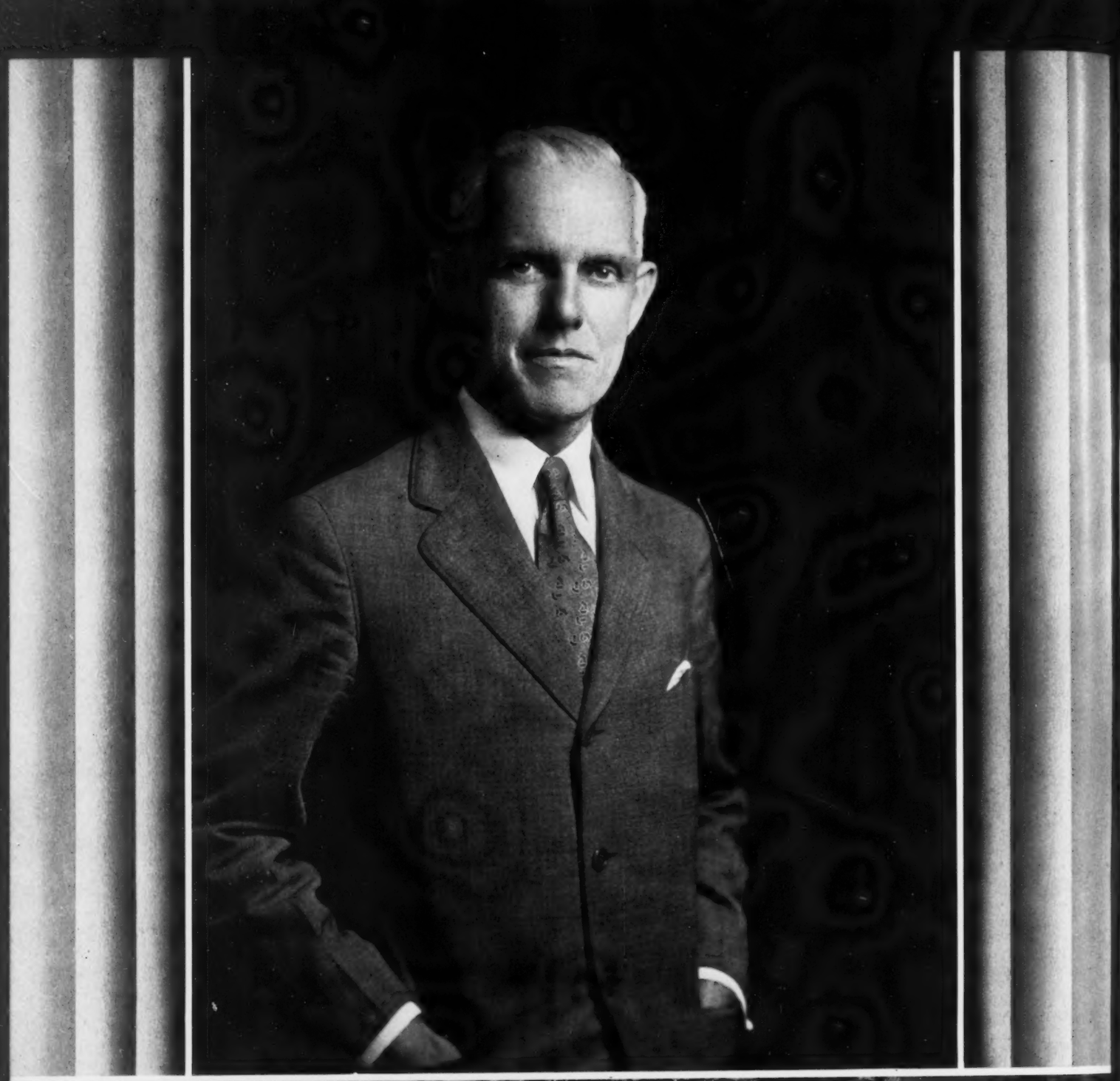
Mr. Johnson's comments on pitting were of particular interest to me for the reason that cases have been observed where pitting was experienced almost immediately with a new set of gears. In most cases the cause of this can be determined and corrected, though occasionally the condition will correct itself. In some cases I have heard the opinion expressed that the pitting may have been due to uneven surface hardness, although, of course, this may be very difficult to prove.

A. W. STEED: Mr. Johnson has presented a paper on a subject very important to steel mill operations, and if his suggestions are followed, improvement in gear and pinion applications are sure to follow. From the heavy cast gears running on open frames and lubricated by heavy tacky dopes remarkable for their ability to stick rather than lubricate, we have advanced to accurately cut steel and alloy gears totally enclosed and scientifically lubricated.

The main difficulties in the past have been design and materials not suited to the requirements for the operation performed. Tooth pressures were often too high for the duty performed. Parts were often too light especially in the frame sections, allowing distortion and misalignment. Lack of proper lubricant has been serious. Improper application of lubricants, overloading due to changes in capacity, and speed of rolling have imposed operating conditions on gears and pinions in our mills other than those anticipated when the equipment was originally designed. Many gears of poor design or material have had their failure covered up by blaming the trouble on the lubricant; on the other hand many well designed gears and pinions have been destroyed through lack of proper lubrication, or through the improper application of the lubricant.


35th Convention and
Iron and Steel Exposition
ASSOCIATION OF IRON AND STEEL ENGINEERS
WILLIAM PENN HOTEL, PITTSBURGH, PA.
SEPT. 26 - 27 - 28 - 29 - 1939

PROGRAM



J. L. Perry President

Carnegie-Illinois Steel Corporation

and *Official Host to* A. I. & S. E. Convention

Carnegie-Illinois Steel Corporation
UNITED STATES STEEL CORPORATION SUBSIDIARY
General Offices, Carnegie Building
Pittsburgh, Pa.

J. L PERRY
PRESIDENT

July 28, 1939

Association of Iron and Steel Engineers,
Empire Building,
Pittsburgh, Pennsylvania.

Gentlemen:

The Carnegie-Illinois Steel Corporation is very glad, indeed, to welcome to Pittsburgh the members of the Association of Iron and Steel Engineers for their Annual Convention on September 26 to 29, inclusive. My associates and I are looking forward to meeting with you and enjoying a program which we know will be both interesting and instructive.

We are pleased to have your membership accept the invitation to visit our recently completed manufacturing unit at Edgar Thomson, and also the complete facilities at the new Irvin Works. These installations represent the most modern development in the production of flat rolled products, and illustrate the remarkable advance in the designing of electrically operated steel mill equipment.

The tremendous advancement in the art of continuous rolling of sheets and strip is truly a mighty tribute to engineers of our country. Your Association has ever been alert in sponsoring technical sessions which stimulate engineering thought and can justly feel proud of its contribution to the technological progress of our industry.

Assuring you that it is always a pleasure for us to cooperate, and wishing you and your organization an eminently successful Conference,
I am,

Sincerely yours,

J. L. Perry
President.

B. F. Fairless

PRESIDENT

United States Steel Corporation

MR. Fairless will be the principal speaker at the banquet to be held on Thursday evening, September 28. Born in Pigeon Run, Ohio, on May 3, 1890, Mr. Fairless moved to Justus, Ohio, where he attended public school. After completing school, he taught school for two years at Rockville and Navarre, Ohio, saving money therefrom to enroll in Wooster College. He transferred later to Ohio Northern University, where he was graduated with a civil engineering degree. Years later, this university conferred on him the honorary degree of doctor of engineering.

Starting his business career with the Wheeling and Lake Erie Railroad as civil engineer in June, 1913, Mr. Fairless transferred in August of that year to the Central Steel Company of Massillon, Ohio. In rapid order he advanced in the company, becoming in turn a mill superintendent, general superintendent, and vice-president in charge of operations. When the United Alloy Steel Corporation and Central merged in September 1926, he was made vice-president and general manager of Central Alloy Steel Company, a position he held until April, 1928, when he became president and general manager of the company. In April 1930, when his company was consolidated into the Republic Steel Corporation, Mr. Fairless became executive vice-president.

When the Carnegie-Illinois Steel Corporation was formed in the autumn of 1935, he was offered and accepted the position of president. In January 1, 1938, Mr. Fairless was elected to succeed William A. Irvin, as president of the United States Steel Corporation of Delaware.

C. Clarke Wales

PRESIDENT

Association of

Iron & Steel Engineers

IN preparation for the 35th Convention and Iron and Steel Exposition, the Association, of Iron and Steel Engineers, the officers of the staff of the Association as well as the exhibitors have put forth every effort to make sure that subjects presented and equipment exhibited include those things which are currently of the most vital interest to steel plant executives, engineers and operators.

We feel sure that those who attend the Convention and diligently interest themselves in all phases of its activities will not only gain inspiration but will return to their daily duties with that greater courage and enthusiasm which is so necessary to progress in any industry.

May I extend on behalf of the exhibitors as well as the officers and staff of the Association, a hearty greeting and welcome to all those in attendance.

All ACTIVITIES

Tuesday, September 26

Iron and Steel Exposition—**9:00 A. M.—10:00 P. M.**

9:00 A. M.—REGISTRATION—Main Lobby

Chairman	*Vice Chairman*
Freeman H. Dyke Superintendent, Blooming, Bar and Hot Strip Mills, Wheeling Steel Corporation Steubenville, Ohio	L. V. Black Electrical Superintendent, Bethlehem Steel Company, Bethlehem, Pennsylvania

9:00 A. M.—LADIES' REGISTRATION—Ladies' Headquarters, Room 1075

9:15 A. M.—BUSINESS SESSION—Forum Room, 17th Floor

Chairman	*Vice Chairman*
C. C. Wales Cleveland, Ohio	J. L. Miller, Assistant Chief Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio

9:30 A. M.—ELECTRICAL ENGINEERING DIVISION—Forum Room, 17th Floor

Chairman	*Vice Chairman*
W. A. Perry Superintendent, Electrical and Power Departments, Inland Steel Company, Indiana Harbor, Indiana	I. N. Tull Electrical Superintendent, Republic Steel Corporation, Cleveland, Ohio

"*A Double Bus System for Power Transmission*", by D. I. Bohn, Electrical Engineer, Aluminum Company of America, Pittsburgh, Pennsylvania, and J. E. Housley, Superintendent of Power, Aluminum Company of America, Alcoa, Tennessee.

"*Vacuum Tube Control for Steel Mill Applications*", by H. L. Palmer, Electronic Section, and H. W. Poole, Steel Mill Section, General Electric Company, Schenectady, New York.

"*The Transition from 25 to 60 Cycle Power in the Steel Industry*", by W. B. Skinkle, Secretary and Engineer, Pittsburgh District Power Committee, United States Steel Corporation Subsidiary Companies, Pittsburgh, Pennsylvania.

12:30 P. M.—*Ladies' Luncheon Bridge*—SOUTH HILLS COUNTRY CLUB

(LADIES WILL MEET IN ROOM 1075 at 11:30 A. M.)

1:30 P. M.—MECHANICAL ENGINEERING DIVISION—Forum Room, 17th Floor

Chairman	*Vice Chairman*
C. J. Duby Chief Engineer, Youngstown and Warren Districts, Republic Steel Corporation, Youngstown, Ohio	J. D. Jones Chief Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio

"*Economics of Advanced Engineering Planning*", by A. R. Schulze, Chief Engineer, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

"*Modernization of Existing Open Hearth Furnaces and Auxiliary Equipment*", by G. L. Danforth, Jr., President, Open Hearth Combustion Company, Chicago, Illinois.

"*Developments in Rolling Flat Steel Products—1939*", by Stephen Badlam, Consulting Engineer, Pittsburgh, Pennsylvania.

1:30 P. M.—WELDING ENGINEERING DIVISION—Parlor, Club Floor

Chairman	*Vice Chairman*
Wray Dudley Assistant Superintendent of Maintenance, National Tube Company, McKeesport, Pennsylvania	E. W. Trexler Maintenance Superintendent, Bethlehem Steel Company, Johnstown, Pennsylvania

"*Stress Relief in Welded Structures*", by Dr. J. C. Hodge, Chief Metallurgist, Babcock & Wilcox Company, Barberton, Ohio.

"*The Welding of Rail Ends and Joints of Crane Runways*", by Wray Dudley, Assistant Superintendent of Maintenance, National Tube Company, McKeesport, Pennsylvania.

"*Welding Electrodes and Their Applications*", by J. H. Deppeler, Chief Engineer, Metal and Thermit Corporation, New York, New York.

"*Automatic Atomic Hydrogen Welding of Steel*", by J. T. Catlett, General Electric Company, Schenectady, New York.

10:00 P. M.—EXHIBITORS' DANCE—Informal—Cardinal Room, 17th Floor

Wednesday, September 27

Iron and Steel Exposition—**9:00 A. M.—10:00 P. M.**

9:00 A. M.—OPERATING PRACTICE DIVISION—Cardinal Room, 17th Floor

Chairman	*Vice Chairman*
H. G. R. Bennett Assistant General Superintendent, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania	W. C. McConnell Plant Superintendent, Republic Steel Corporation, Massillon, Ohio

Symposium on the Preparation of Steel for Subsequent Rolling:

"*Preparation of Semi-finished Steel*", by A. P. Spooner, Metallurgical Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania.

UNDER One ROOF

"Mechanical Billet Chipping", by G. W. Lentz, Chief Engineer, Bonnot Company, Canton, Ohio.

"Steel Conditioning with the Oxy-acetylene Method", by G. D. Winlack, Air Reduction Sales Company, New York, New York.

"Billet Grinding", by A. Rousseau, Norton Company, Worcester, Massachusetts.

11:30 A. M.—*Ladies' Sight-seeing Trip:* H. J. Heinz Company, Cathedral of Learning, Stephen Foster Memorial, and Heinz Chapel. (LADIES MEET IN ROOM 1075 at 11:15 A. M.)

12:45 P. M.—*Inspection Trip:* 80 in. Hot and Cold Strip Mills, Irvin Works, Carnegie-Illinois Steel Corporation, Dravosburg, Pennsylvania.

Thursday, September 28

Iron and Steel Exposition—**9:00 A. M.—5:30 P. M.**

9:00 A. M.—ELECTRICAL ENGINEERING DIVISION—Cardinal Room, 17th Floor

Chairman	*Vice Chairman*
K. E. Dinius Electrical Engineer, Carnegie-Illinois Steel Corporation, South Chicago, Illinois	L. R. Milburn Electrical Engineer Great Lakes Steel Corporation, Ecorse, Michigan

"Gauge Control for Cold Strip Mills", by F. Mohler, Electrical Engineer, Steel Mill Section, General Electric Company, Schenectady, New York.

"Power Requirements of Cold Strip Mills", by A. F. Kenyon, Steel Mill Engineer, Industrial Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

"Development in Electrical Truck Transportation in Continuous Sheet and Strip Mills", by C. B. Crockett, Industrial Truck Statistical Association, Chicago, Illinois.

9:00 A. M.—COMBUSTION ENGINEERING DIVISION—Forum Room, 17th Floor

Chairman	*Vice Chairman*
G. M. Coughlin Combustion Engineer, American Rolling Mill Company, Ashland, Kentucky	P. F. Kinyoun Combustion Engineer, Bethlehem Steel Company, Lackawanna, New York

"Types and Selection of Refractories for the Steel Plant", by J. S. McDowell and J. P. Bankson, Harbison-Walker Refractories Company, Pittsburgh, Pennsylvania.

"Observations on the Heating of Steels from the Metallurgical Viewpoint", by E. E. Callinan, Combustion Engineer, and Gilbert Soler, Director of Research, Steel and Tube Division, Timken Roller Bearing Company, Canton, Ohio.

"Modern Gas-Mixing Systems as Applied to Steel Plant Requirements", by G. M. Arnold, Industrial Division, Cutler-Hammer, Inc., Chicago, Illinois.

1:30 P. M.—OPERATING PRACTICE DIVISION—Forum Room 17th Floor

Chairman	*Vice Chairman*
J. G. West, Jr. District Superintendent, Blast Furnace and Coke Ovens, Youngstown Sheet and Tube Company, East Chicago, Indiana	A. H. Fosdick Superintendent Blast Furnace and Sintering Plant, Bethlem Steel Company, Bethlehem, Pennsylvania

"Yields of Coke and By-Products from Various Coals", by J. D. Davis, Senior Fuels Chemist, Central Experiment Station, Bureau of Mines, Pittsburgh, Pennsylvania.

"Reasons for Adopting Certain Details in the Design of the New Inland Blast Furnace", by Hjalmar W. Johnson, Superintendent of Blast Furnces, Inland Steel Company, Indiana Harbor, Indiana.

"Reconstructed Blast Furnace Shell of Welded Design", L. J. Gould, Assistant Chief Engineer of Construction, Bethlehem Steel Company, Bethlehem, Pennsylvania.

1:30 P. M.—LUBRICATION ENGINEERING DIVISION—Cardinal Room 17th Floor

Chairman	*Vice Chairman*
F. L. Gray Lubrication Engineer, Carnegie-Illinois Steel Corporation, Gary, Indiana	T. R. Moxley General Master Mechanic, Wheeling Steel Corporation, Steubenville, Ohio

"Modern Lubrication of Existing Equipment", by F. J. Thomas, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio.

"Progress of Lubrication in the Steel Mills", by C. C. Pecu, Lubrication Engineer, Bethlehem Steel Company, Lackawanna, New York.

"Causes of Gear Wear and Failure", by J. H. Jones, Metallurgist, Republic Steel Corporation, Massillon, Ohio.

7:30 P. M.—FORMAL BANQUET AND DANCE

BANQUET—Main Lobby
DANCE—Cardinal Room, 17th Floor

Speakers: B. F. Fairless, President, United States Steel Corporation, Pittsburgh, Pennsylvania

Strickland Gillilan, Author, Journalist, and Commentator.

Friday, September 29

Iron and Steel Exposition—**10:00 A. M.—3:00 P. M.**

9:00 A. M.—*Inspection Trip:* Edgar Thomson Works, Carnegie-Illinois Steel Corporation, Braddock, Pennsylvania.

CONVENTION COMMITTEES

GENERAL CHAIRMAN OF CONVENTION AND EXPOSITION

Chairman
C. Clarke Wales
Cleveland,
Ohio

Vice Chairman
R. R. Thomas, *Assistant Chief Engineer*
Tennessee Coal, Iron and Railroad Company
Ensley, Alabama.

GENERAL CONVENTION COMMITTEE

Chairman
Julius A. Clauss
Chief Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

Vice Chairman
Frank E. Flynn
District Manager
Republic Steel Corporation
Warren, Ohio

REGISTRATION COMMITTEE

Chairman
Freeman H. Dyke
Superintendent
Bloom, Bar and Hot Strip Mill
Wheeling Steel Corporation
Steubenville, Ohio

Vice Chairman
L. V. Black
Electrical Superintendent
Bethlehem Steel Company
Bethlehem, Pennsylvania

IRON AND STEEL EXPOSITION COMMITTEE

Chairman
Walter H. Burr
Superintendent, Electrical Department
Lukens Steel Company
Coatesville, Pennsylvania

Vice Chairman
H. W. Neblett
Development and New Design Engineer
Inland Steel Company
East Chicago, Indiana

COMMITTEE ON ATTENDANCE

Chairman
Louis F. Coffin
Superintendent, Mechanical Department
Bethlehem Steel Company
Sparrows Point, Maryland

Vice Chairman
Frank P. May
Assistant Chief Engineer
By-product Coke Works
Carnegie-Illinois Steel Corporation
Clairton, Pennsylvania

FORMAL RECEPTION COMMITTEE

Chairman
C. Clarke Wales
Cleveland, Ohio

Vice Chairman
L. H. Burnett
Vice President
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

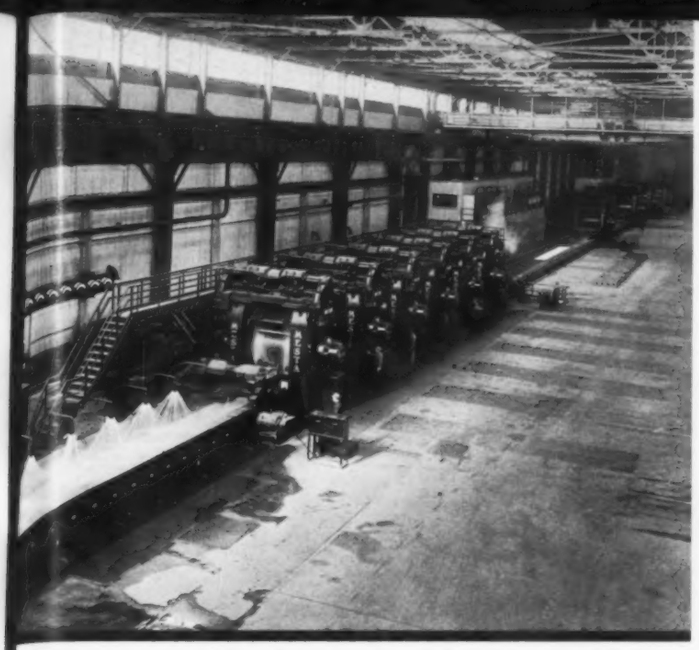
LOCAL PITTSBURGH DISTRICT SECTION ENTERTAINMENT COMMITTEE

Chairman
Charles L. McGranahan
Assistant General Superintendent
Pittsburgh Works
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

Vice Chairman
T. E. Hughes
Superintendent, Maintenance
Carnegie-Illinois Steel Corporation
Duquesne, Pennsylvania

H. H. Wood
J. K. Mahaffey
John L. Young
Donald I. Bohn
L. F. Worden
Bon J. Ballard
J. K. Keogh
Emmett F. Cary

R. W. Leech
R. E. Brown
W. D. Falkenstein
Ross E. Willis
Thomas S. Towle
M. B. Farrar
Gordon First
Harry Robb



INSPECTION TRIPS

Irvin Works

CARNEGIE-ILLINOIS STEEL CORP.

WEDNESDAY, SEPTEMBER 27

The Inspection Trip to the Irvin Works of the Carnegie-Illinois Steel Corporation Wednesday, September 27, will originate at the Wm. Penn Hotel. The first bus will depart at 12:45 P.M. from the Grant Street entrance. Officials of the Carnegie-Illinois Steel Corporation have requested those making the trip to use the special transportation facilities which will be provided by the Association; otherwise they will not be permitted to enter into the plant.

Tickets for this trip will be on sale at the registration desk in the lobby of the Wm. Penn Hotel the first day of the Convention.

The same general plan used in connection with the trip to the Irvin Works will be in effect for the trip to the Edgar Thomson Plant of the Carnegie-Illinois Steel Corporation on Friday morning, September 29. The first bus will depart from the Wm. Penn Hotel at 9:00 A.M. and everyone wishing to make this trip must use these special facilities. Tickets for this trip will also be on sale the opening day of the Convention.

Edgar Thomson Works

CARNEGIE-ILLINOIS STEEL CORP.

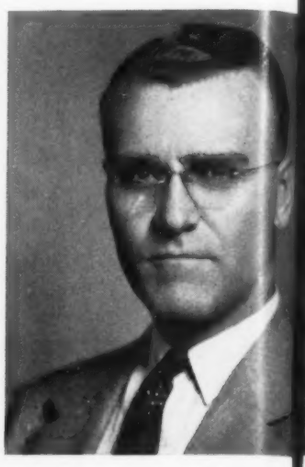
FRIDAY, SEPTEMBER 29

PRESIDING OFFICERS *and*

J. T. CATLETT

FREEMAN H. DYKE

A. P. SPOONER



J. H. JONES

GILBE

K. E. DINIUS

W. B. SKINKLE

L. H. BURNETT

P. F. KINYOUN

I. N

J. L. MILLER

W. C. McCONNELL

H. W. POOLE

L. J. GOULD

C. B. C

AUTHORS at CONVENTION

GILBERT SOLER

J. S. McDOWELL

F. L. GRAY

J. C. HODGE

I. N. TULL

J. H. DEPPELER

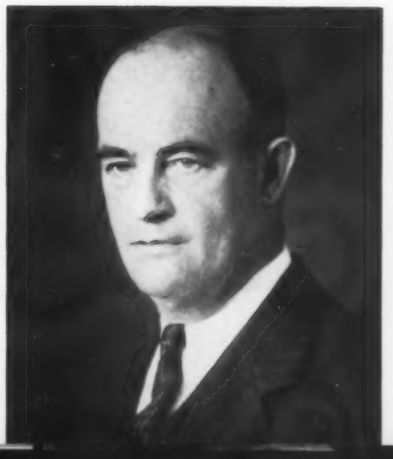
J. P. BANKSON

H. L. PALMER

C. B. CROCKETT

EDWARD E. CALLINAN

J. D. JONES



G. M. ARNOLD

PRESIDING OFFICERS *and*

A. R. SCHULZE

J. G. WEST, JR.

L. V. BLACK

F. MOHLER

L. R.

C. J. DUBY

J. E. HOUSLEY

G. L. DANFORTH, JR.

G. M. COUGHLIN

J. D

WRAY DUDLEY

H. G. R. BENNETT

G. D. WINLACK

W. A. PERRY

STEPHE

AUTHORS at CONVENTION

L. R. MILBURN

G. W. LENTZ

E. W. TREXLER

A. H. FOSDICK

J. D. DAVIS

A. ROUSSEAU

T. R. MOXLEY

A. F. KENYON

STEPHEN BADLAM

F. J. THOMAS

H. W. JOHNSON

C. C. PECU

. . . Don't Fail to Visit the I

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Iron & Steel Exposition

SPONSORED BY

ASSOCIATION OF IRON AND STEEL ENGINEERS

WILLIAM PENN HOTEL - PITTSBURGH, PENNA.

SEPTEMBER 26 - 27 - 28 - 29, 1939

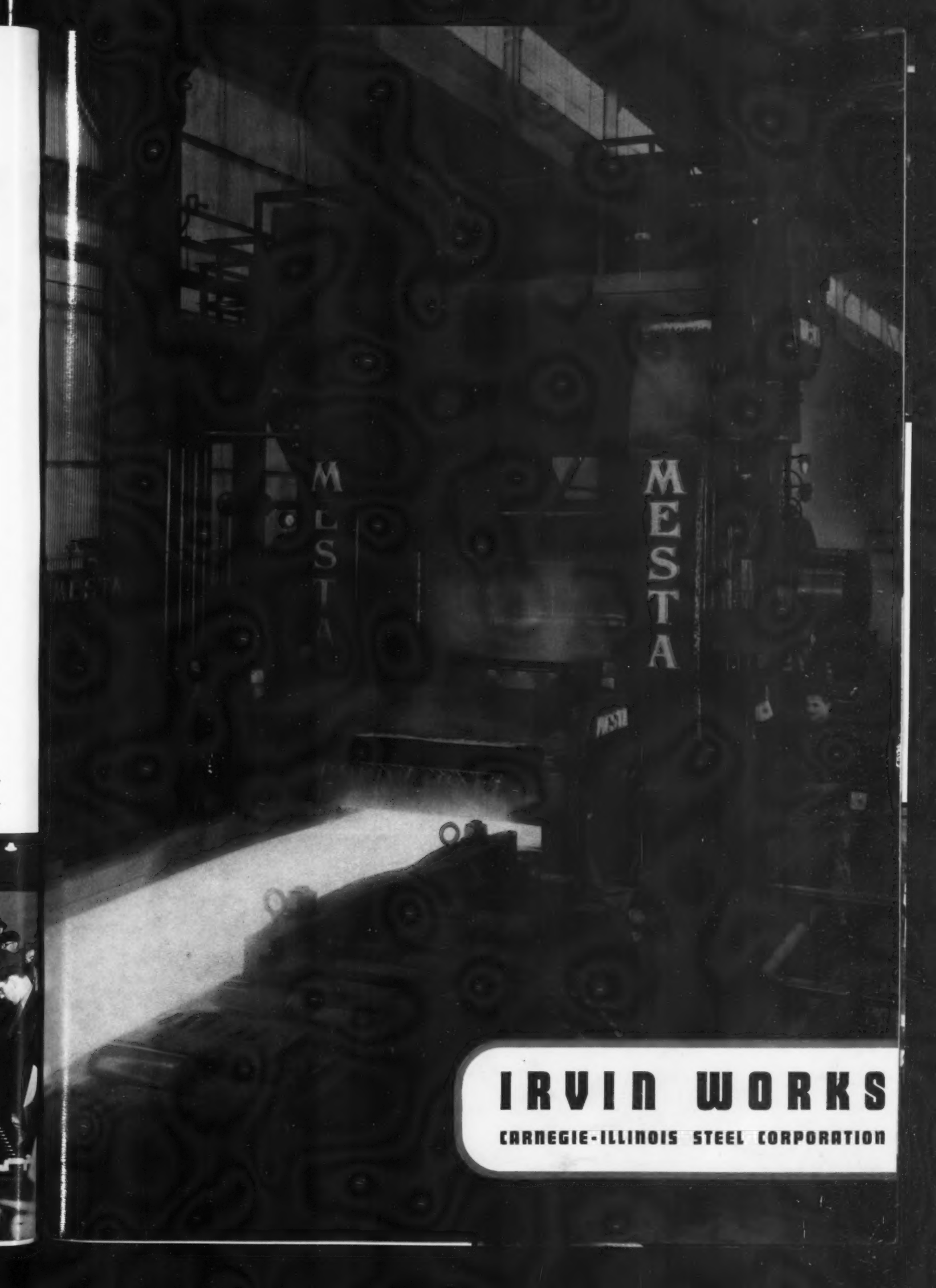
PRESENTING the latest developments in the products of over 100 manufacturers of steel plant equipment, the annual Iron and Steel Exposition, held in conjunction with the annual Convention of the Association of Iron and Steel Engineers, offers much of interest to engineering and operating men of the iron and steel industry.

Utilizing 20,000 sq. ft. of space, the exhibits offer a complete cross-section of the engineering applications in the industry and will prove of universal appeal to those who desire to keep abreast of the new improvements. The Exposition will be held in the Wm. Penn Hotel, in close proximity to the technical sessions and other activities of the Convention. This placing of all activities under one roof facilitates complete participation in all Convention activities.

Exhibits will be located in the Ball Room, Urban Room, Silver Room and Adonis Room on the 17th floor of the hotel. This floor will have approximately 50 per cent of the exhibits and the remainder will be in the Chatterbox and Italian Terrace rooms on the first floor of the hotel.

EXPOSITION HOURS

TUESDAY, SEPT. 26—9:00 A. M. to 10:00 P. M.
WEDNESDAY, SEPT. 27—9:00 A. M. to 10:00 P. M.
THURSDAY, SEPT. 28—9:00 A. M. to 5:30 P. M.
FRIDAY, SEPT. 29—9:00 A. M. to 3:00 P. M.


MESTA
MESTA
IRVIN WORKS
CARNEGIE-ILLINOIS STEEL CORPORATION

"The Most Modern Mill in the World"

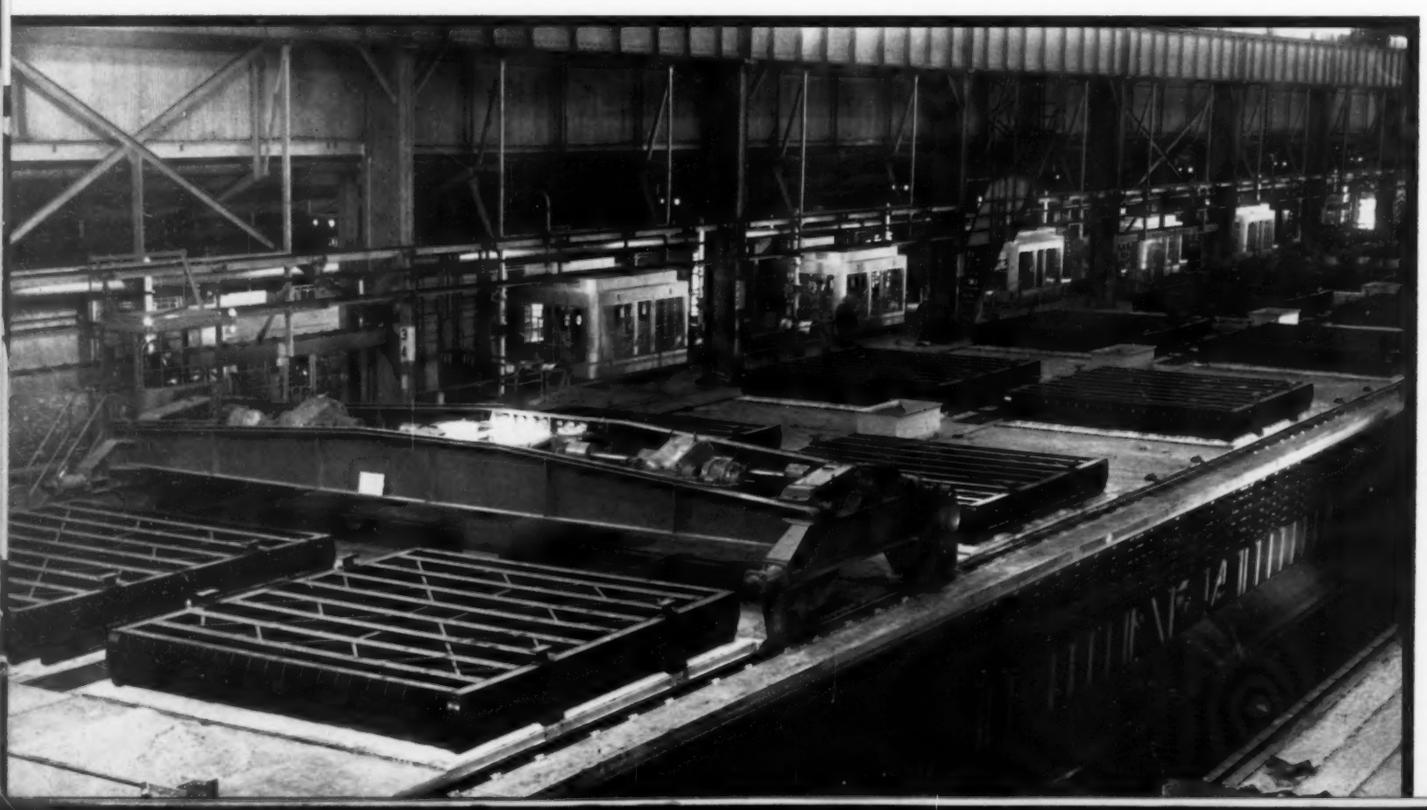
▲ IN order to better serve its customers in the eastern district, the Carnegie-Illinois Steel Corporation has made various installations in the Pittsburgh area that will furnish a complete diversification of finished products. The latest of these is the new Irvin Works, which is capable of producing 672,000 net tons per year of high quality strip products, including cold reduced coils, tin plate, black plate, and sheets ranging from twelve-one-thousandths to one-quarter of an inch in thickness. The plant has been named in honor of William A. Irvin, former president of the United States Steel Corporation. At appropriate ground breaking ceremonies attended by thousands of residents from surrounding communities, together with officials of both corporations, Mr. Irvin turned the first earth on May 22, 1937.

All past traditions, which kept steel mills to the bottoms of the valleys, were disregarded by the management when they chose a hillside 227 feet above the normal pool level of the Monongahela river as the site. Preparation of this site necessitated leveling of rolling hills, filling of deep gullies and depressions, and gouging out a flanking ridge to bring the whole to one level tract 6,200 feet long and 1,800 feet wide. The deepest fill was 142 feet and the maximum cut 137 feet. Over 100 pieces of heavy earth and rock handling equipment, working day and night, were required to move the 4,300,000 cubic yards of material involved. Night work was done under huge batteries of floodlights mounted on high wooden towers on a hillside overlooking the tract. Interwoven with the excavating and leveling operations were the laying of miles of sewers and railroad tracks, the pouring of concrete foundations, and the erection of buildings, all so scheduled that there was no interference between units or unnecessary delays in construction. Materials excavated ranged all the way from soft muck, through shale, "red dog" and coal, to rock. Ten thousand to eighteen thousand pounds of explosives were used daily for blasting purposes.

The project entailed pouring 245,000 cubic yards of concrete, placing 12,000 tons of foundation steel, and erecting 33,000 tons of structural steel. All buildings, except the slab storage, are floored with concrete, with wood block sections where men are constantly at work and brick flooring in heavy traffic areas. Buildings are so designed as to afford the best results obtainable in light and ventilation. Forced draft unit heaters provide heat during the cold months. A glance at the following table will give an idea as to the magnitude of the project.

Excavation started	May 22, 1937
Material excavated	4,300,000 cu. yds.
Concrete poured	245,000 cu. yds.
Reinforcing steel	20,000,000 pounds

Sixteen new soaking pits, totaling a heating capacity of over 2,000,000 tons per year, furnish hot ingots for slabbing mill.



Anchor bolts and miscellaneous foundation steel	4,000,000 pounds
Bearing piles	13½ miles
Construction track	17½ miles
Permanent railroad track	13½ miles
Structural steel	33,000 gross tons
Concrete floors	200,000 sq. yds.
Skylights	34,000 sq. yds.
Area under roof	51½ acres
Area of plot	653 acres
Sewers: Temporary	11,000 feet
Sewers: Storm	53,000 feet
Sewers: Sanitary	20,000 feet
Contractors (Exclusive of U. S. Steel Corporation subsidiaries)	1102
Electrical conduit	200 miles
Piping	105 miles
Motors	2000
Installed horsepower	300,000
Largest motors	(5) 10,000 hp.
First unit in production (5-stand tandem)	March 21, 1938

J. L. PERRY, *President*
Carnegie-Illinois Steel Corporation

SLABS FROM EDGAR THOMSON WORKS

To obtain an adequate supply of slabs to be transformed into strip at the Irvin Works, a new slabbing mill installation was put in at the Edgar Thomson Works, Braddock, Pennsylvania. This plant is one of the older major units of the corporation, and consists, in addition to the new slabbing mill, of eleven blast furnaces, sixteen open hearths, four converters, blooming mills, rail and bar mills, and the recently installed slabbing mill, with a total annual production capacity of over 2,038,500 net tons of steel. A program of open hearth enlargement is in progress, together with modernization of the blast furnaces.

The soaking pits are of modern design and are completely equipped with automatic controls, which are mounted and housed in individual control rooms.

The slabbing unit, with a nominal capacity of 1,680,000 net tons per year, is a 44 in. universal mill, having one pair of horizontal rolls and one pair of vertical rolls, all working on the piece at the same time.

The mill is fed from sixteen recuperative pit furnaces arranged in a double row of eight in a building 100 ft. wide by 420 ft. 6 in. long. Each pit is 15 ft. by 16 ft., and about 8½ ft. deep when bottom is made. Fuel, a mixture of coke oven gas and natural gas, is introduced through a single burner located in the center of the furnace bottom, the gas traveling up through the center of the furnace, looping over the top of the ingots and back down the sides of the furnace to the flues. Complete fuel-air ratio control, temperature control, and furnace pressure control are provided on each pit. Variations in fuel gas composition are automatically

H. G. McILVRIED,

General Superintendent, Irvin Works

cared for by a density meter which adjusts the gas-air ratio control so that the desired furnace atmosphere is constantly maintained. As the steel reaches the desired temperature, the temperature controller reduces air flow, in response to which the ratio controller reduces gas flow. Pit covers are handled by four low-head cranes running on tracks along the rows of pits.

The furnaces are charged with six to ten ingots, depending on the size of ingot, which may range up to 45,000 or 55,000 lb. in weight. Material is charged into and drawn from the furnaces by three 25-ton overhead pit cranes. An ingot buggy runs the entire length of the row of pits, about 340 ft., attaining speeds of 600-1000 ft. per min., and is controlled by an operator at the mill table.

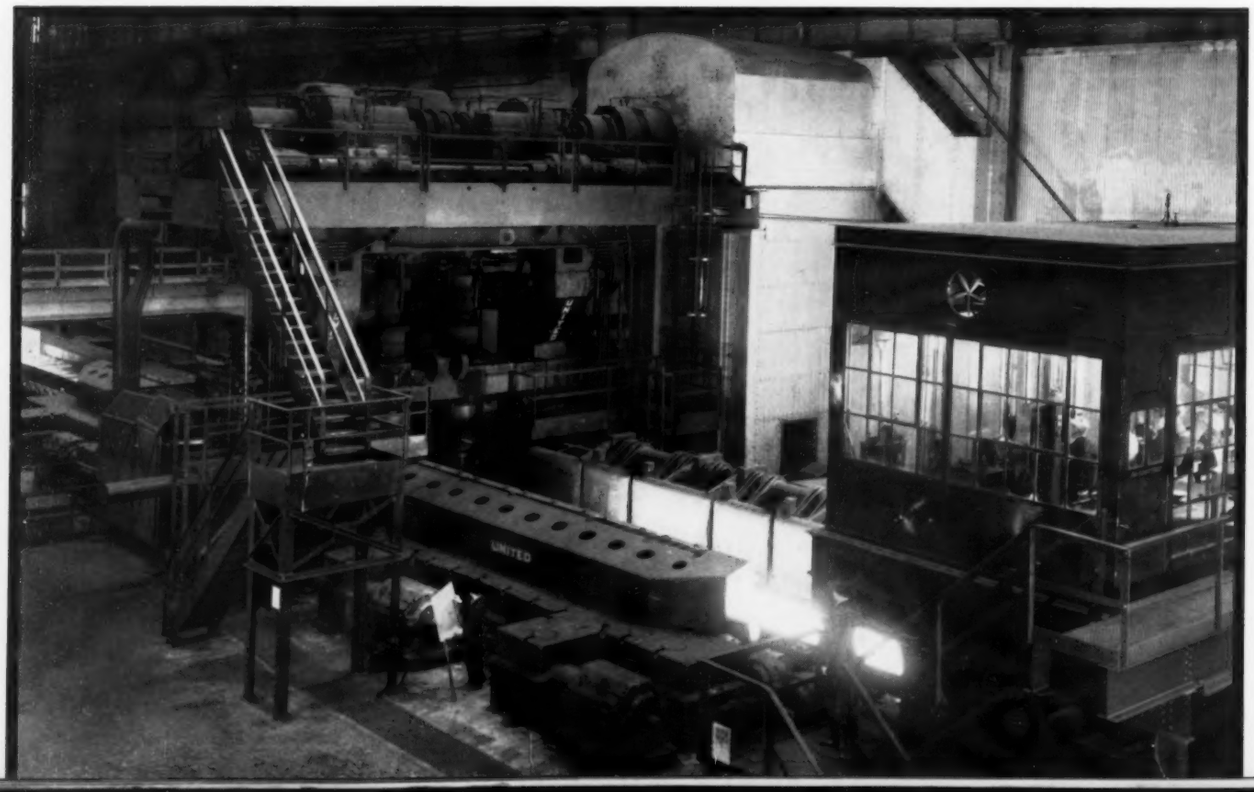
The mill building, 100 ft. wide by 358 ft. long, is a continuation of the pit furnace building, and is served by a 75 ton crane with 25 ton auxiliary hoist, of 95 ft. 2 in. span. The mill tables extend for an overall length of about 360 ft. Ingots are deposited from the ingot buggy on to the mill table, and before proceeding to the mill about 115 ft. distant, pass over a turn table which can reverse the position of the ingot, end for end, if desired.

Horizontal rolls of the mill, which are 45 in. diameter x 80 in. body length, are individually driven, each roll by a 5000 hp., 0-40-80 rpm., 700 volt d-c. reversing motor. A roll surface speed up to 940 ft. per min. is obtained, while a maximum opening of the rolls is 65 in. Two 200 hp. screwdown motors effect horizontal roll adjustments.

The vertical rolls are located on the exit side of the mill, and are driven through bevel gearing by a 3000 hp., 0-60-180 rpm., 700 volt d-c. reversing motor. These rolls have body dimensions of 36 in. diameter and 80 in. length, and are adjustable to give a horizontal opening of 18-82 in. This adjustment is made through two 75 hp. motors.

The control of the roll drives is a conventional variable voltage system in which speed of all three motors is simultaneously adjusted for various speeds and conditions encountered. All three motors receive power from a flywheel motor-generator set consisting

On the universal slabbing mill vertical rolls are driven by a motor located in the top of enclosure to right of mill.



of three 3500 kw. 700 volt d-c. generators driven by a 7500 hp., 360 rpm., 6600 volt wound rotor induction motor.

Variable voltage control has also been applied to certain mill auxiliary units on which severe duty is imposed, including the two 200 hp. screwdown motors, four 150 hp. manipulator motors, two 150 hp. motors on tables adjacent to the mill stand, and two 350 hp. shear motors. These motors draw power from two motor-generator sets, each composed of one 350 kw., two 200 kw., and two 150 kw. d-c. generators, all driven by a 1250 hp. 6600 volt synchronous motor.

About 153 ft. beyond the mill is a 1200 ton, 80 in., double cut shear driven by two 350 hp. motors. This shear will cut slabs up to 9 in. thick by 60 in. wide, into lengths up to 18 ft. Shear crops are carried to a railroad car over a flight drag type conveyor.

Beyond the shear the mill table extends about 92 ft., where pushers move the slabs from the mill table to a transfer, which carries then to a loading table paralleling the mill table about 73 ft. away. The loading table is 225 ft. long, and has two pilers at each end. From the pilers, slabs are moved by overhead crane to the slab storage. All rollers in the mill tables are of solid forged steel, and run in roller bearings. The tables are driven in sections through line shafts by d-c. motors of suitable size.

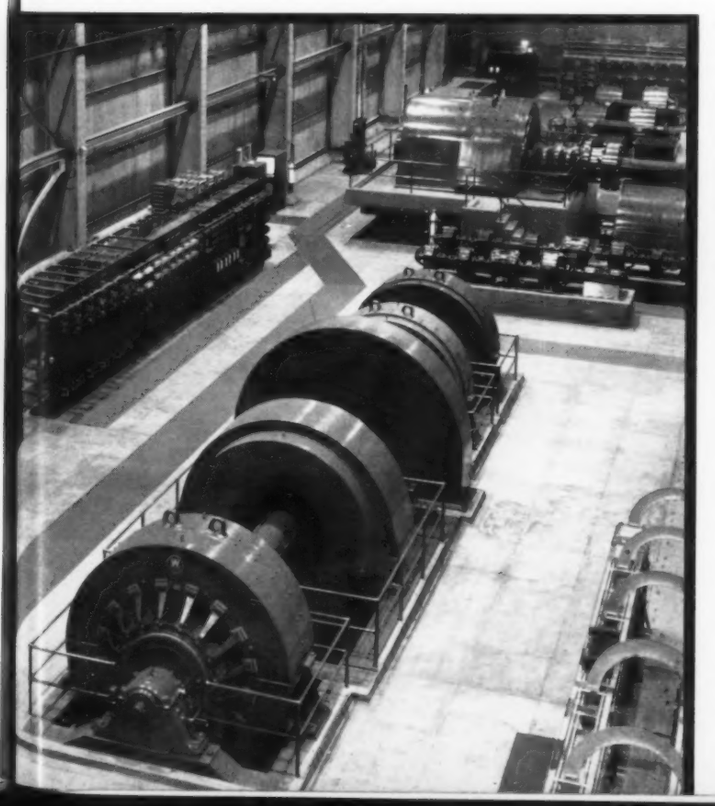
Horizontal and vertical roll necks run in babbitted bearings with brass inserts, which are lubricated with a heavy grease from an automatic grease system. Other grease systems provide lubrication for the roller bearings of the mill table rollers. Automatic circulating oil systems serve main mill motors and motor-generator sets and various mill auxiliaries.

Scale handling is effected hydraulically by the sluice

H. L. BRINDLE,

General Superintendent, Edgar Thomson Works

View of slabbing mill motor room, showing twin motors driving horizontal mill rolls in background, motor-generator set in foreground.



After careful inspection, surface defects on slabs for Irvin Works are removed by scarfing, using hand oxy-acetylene torches.

L. S. DAHL,

Assistant General Superintendent, Irvin Works

running underneath the full length of the mill and the ingot buggy runway. Scale is carried by the flow of water into a large scale pit to one side of the mill, from which it is removed by clam-shell bucket and crane.

The lighting system consists of high-bay units hung from the bottom chord of the roof truss with shock-absorbing hangers, and is designed for an intensity of 10 foot-candles in the mill proper and in the motor-room, with 5 foot-candles elsewhere. Outlet points are fed from 50 kva., 440-220-110 volt, non-inflammable transformers located at definite load centers.

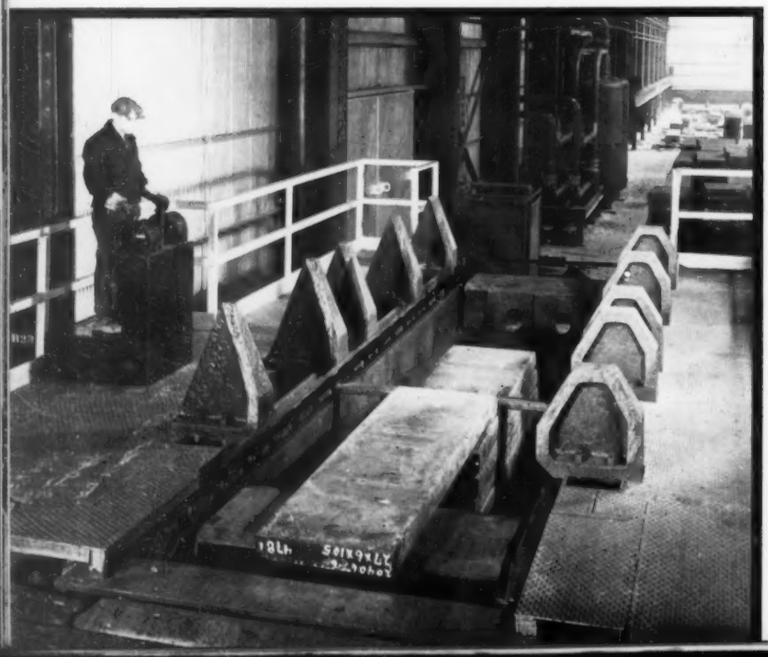
Power is brought to the slabbing mill through a transformer bank consisting of three oil-insulated outdoor type 66,000-6,600 volt transformers, each rated at 4,000 kva. self-cooled and 5,300 kva. with blowers. The low side of this bank feeds into an 8-place metalclad switchgear line-up, containing oil circuit breakers insulated for 15,000 volts with interrupting capacity of 250,000 kva. This switching equipment, together with main mill drives and other electrical equipment previously mentioned, are placed in the motor room adjacent to the mill building. Also located here are two 1,500 kw. motor-generator sets for auxiliary d-c. power and a bank of three single phase 1,000 kva. 6,600-440 volt transformers. The motor-room is ventilated by recirculation of air from the room down through the rotating units, through surface type coolers located in the basement, and back into the motor-room. Total capacity of the recirculating fans is approximately 500,000 cu. ft. per min. Two make-up air units, each rated at 40,000 cu. ft. per min., employ traveling air filters of the oil-coated impingement type. A concrete tunnel, lined with a steel shell, runs the entire length of the mill and connects with the motor room. Steel shelving runs through this tunnel, upon which lie lead covered cables carrying power to the various auxiliary motors located in the mill building.

The slabbing mill was designed on the basis of an average production rate of 280 net tons per hour, and produces slabs ranging 18-60 in. in width, 3-8 in. in thickness and, 5-18 ft. in length.

IRVIN WORKS

Slabs are shipped by railroad a distance of seven miles to the slab storage at Irvin Works. This building is 124 ft. 9 in. wide and 864 ft. long and has a storage capacity of 76,000 net tons. Here the slabs are unloaded by three 40 ton overhead cranes with 15 ton auxiliary hoists, and segregated into groups comprising about 25 different types of steel.

When an order is received, slabs of the required properties and composition are transferred from the storage groups by crane to scarfing docks at either end of the building. Here, after close inspection, they are conditioned for rolling by removing all surface defects through the use of oxy-acetylene torches. They are then carried by crane to either of two elevating magazine feeders located at either end of the charging table running across the charging end of the slab heating furnaces, which extend, at right angles to the building, into the hot strip mill. The feeder table is raised until the top slab is on a level with the charging table to which the slab is pushed by means of an endless chain mechanism



Slabs are piled in the magazine depiler, and raised to allow one slab at a time to be pushed off by bars on the chain.

equipped with cross bars. This roller table carries the slab into position for charging into one of the slab heating furnaces.

JOHN LLOYD,

Assistant General Superintendent,

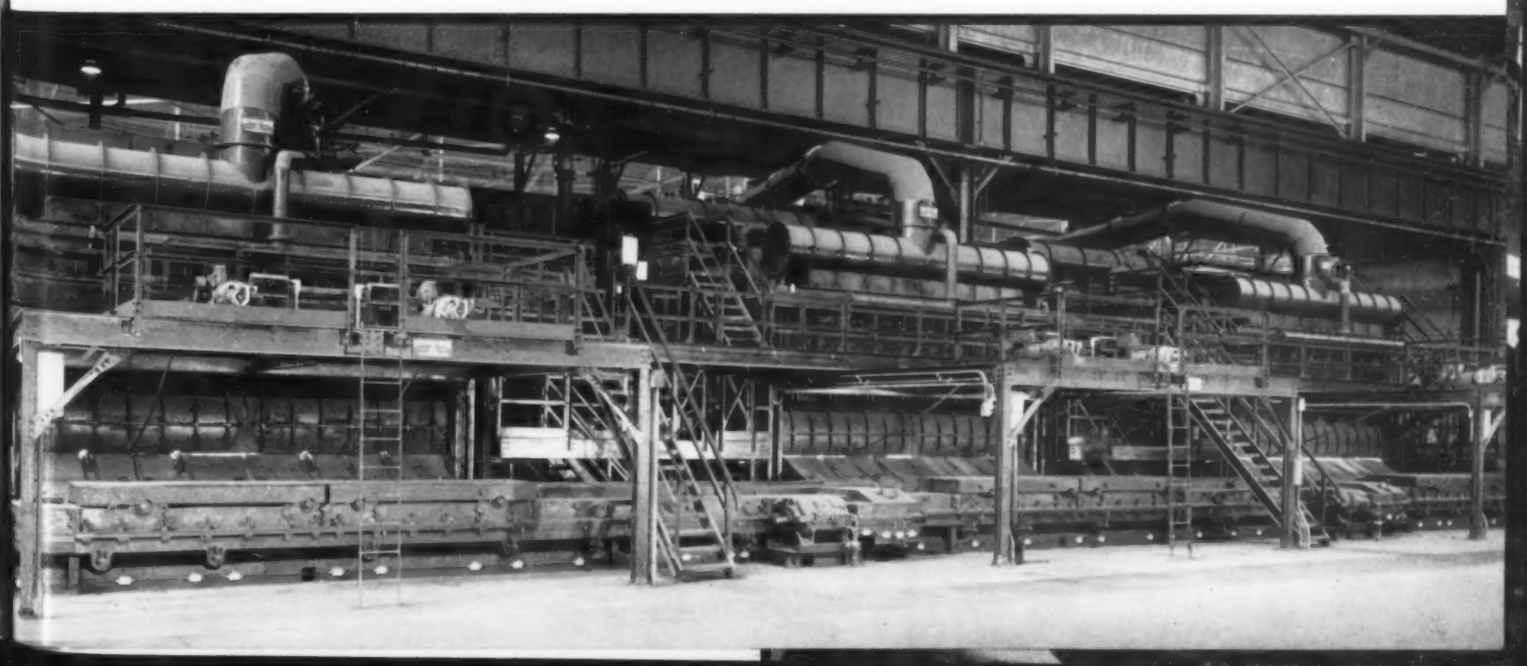
Edgar Thomson Works

SLAB HEATING

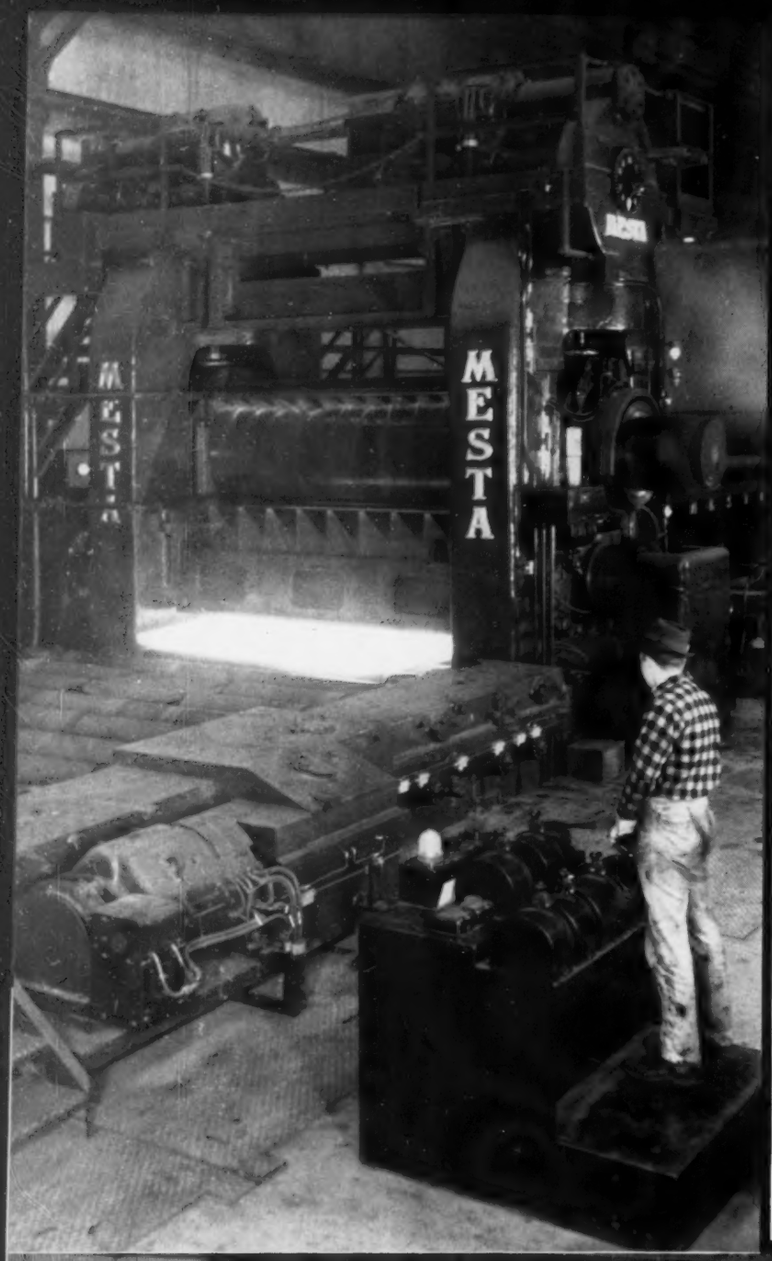
Three zone controlled, triple-fired, recuperative, continuous heating furnaces provide ample slab heating capacity for the mill. Each furnace measures 80 ft. long by 20 ft. wide and is capable of heating 60 gross tons per hour to a maximum of 2400 degrees F. The furnaces are normally fired with by-product coke oven gas and are equipped with automatic combustion and temperature control. Natural gas may be used, as may also a mixture of the two gases. Approximately 500,000 cu. ft. of by-product coke oven gas per hour is required to heat the furnaces. Preheated air at 600 degrees F. is obtained by passing the burned hot gases through the recuperators. Air is pulled through the recuperators by a motor driven fan on each furnace, rated at 50,000 cu. ft. per min. at 600 degrees F. and 3½ in. water column. Flue gas is conducted through underground flues to individual stacks, 150 feet high, or can be diverted to be used on two waste heat boilers where it is used to generate about 30,000 pounds of steam per hour at 200 pounds per square inch pressure at 520 degrees F. This steam is used for heating and operating purposes throughout the plant.

The slabs move through the first 60 feet of the furnaces on water-cooled skids which permit heating on both tops and bottoms of slabs. These skids use about 100,000 gallons of cooling water per hour. The last 17 feet of the furnaces have a flat chrome ore bottom where the slabs are brought to a uniform temperature throughout. Accurate control of temperatures in all parts of the furnaces is facilitated by a battery of recording and indicating instruments located at the side of each furnace. A quick glance at these control panels tells the operator whether or not the proper temperatures are being maintained, whether proper proportions of air and gas are being used, and such information as he requires to deliver properly heated slabs to the mill. Doors are provided along the sides of the furnaces, for observation purposes and to permit manual adjustment of slabs if desired.

When the slabs are in the correct charging position on the charging table, they are shoved into the furnace



Three continuous furnaces, 80 ft. x 20 ft., and totaling over 200 net tons per hour capacity, provide hot slabs for the strip mill.



by pushers operated by 50 hp. 500 rpm. d-c. motors through worm reduction drives. They are controlled from two pulpits behind and slightly above the charging tables. The doors of the furnaces are also controlled from these pulpits and are so arranged that when the charging door is opened to push a slab into the furnace, the door on the delivery end simultaneously opens, permitting a slab to be discharged out over an apron onto a roller table.

HOT STRIP MILL

Slabs are discharged from the heating furnaces at temperatures ranging from 2000 to 2400 degrees F., depending upon the grade of steel and thickness of finished strip. They are brought up to the mill over a roller table 208 ft. long, which is sectionalized into five units, each being driven by a 50 hp., 550 rpm., d-c. motor. Table is reversible, so that, if necessary, slabs can be returned to slab storage over a chain type transfer located parallel to and north of the furnaces.

The first unit in the 80 in. hot strip mill is the No. 1 scalebreaker, a two-high, 36 in. by 66 in. stand operated at 302 feet per minute and driven by a 1250 hp., 660 volt, 250 rpm., a-c. induction type motor through a single reduction gear drive, which is equipped with two 13 ft. 8 in. flywheels having a total energy content of

In the broadside stand, slabs may be cross-rolled, spreading them up to the maximum width that can be rolled in following stands. LEFT

View showing strip passing through water sprays as it leaves the finishing train. Roughing stands may be seen in the background.

J. H. ELLIOTT,

Assistant to General Superintendent, Irvin Works

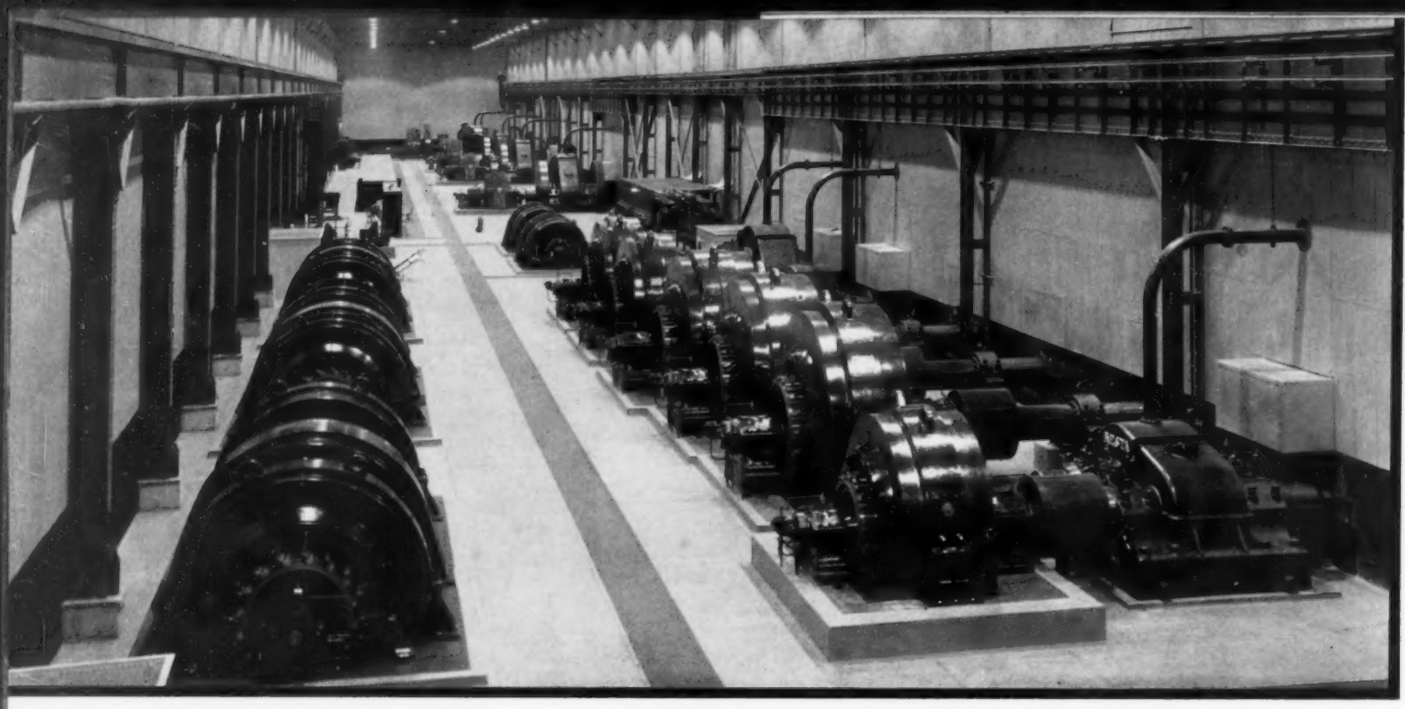
E. T. LORIG,

Chief Engineer, Irvin Works

25,328 hp.-seconds to smooth out the load curve. A slight reduction in this stand serves to crack and loosen the primary scale, which is then removed by 1300 lb. per sq. in. pressure hydraulic jets. Following this stand the slab passes over a reversible table for a distance of 23 ft. 2 in. at a speed of about 188 feet per minute to the first roughing stand, which is a four-high 38 in. and 51 in. by 130 in. mill operated at about 190 feet per minute and driven through a gear set by a 3500 hp., 6600 volt, 150 rpm., a-c. induction type motor having a shaft mounted flywheel of 45,400 hp.-seconds energy content. This stand is a broadside mill in which slabs up to 127 in. in length can be spread to a maximum of 77 in. in width in a single pass in order to obtain strip widths greater than those of the original slabs. A screw type slab pusher on the entry side of this stand assures square and proper entry of the slab between the rolls. Slab turn-arounds are provided in this table before and after this stand. These turn-arounds turn the slab through 90 degrees. Following the broadside mill, a slab squeezer serves to true up slab edges and widths and to flatten out slabs for subsequent rolling. This squeezer has a 13 foot head with a maximum stroke of 7 inches on a 6 inch slab. Slabs reach the squeezer and pass to the second roughing stand over a reversible roller table 59 ft. 1 in. long, which is in two independent sections, each being driven by a 50 hp., 550 rpm., reversible d-c. motor. Table speed is about 188 feet per minute.

The second roughing stand is a 38 in. and 51 in. by 80 in. universal type, four-high mill with vertical edging rolls mounted on the entry side of the stand. This roughing mill is driven by a 3500 hp., 257 rpm., a-c. induction motor. Gear drive is equipped with two 13 ft. 8 in. flywheels having a total energy content of 43,500 hp.-seconds. The edging rolls are driven through twin worm reduction sets by a 150 hp., 450-900 rpm., d-c. motor. After leaving this stand, the slab passes over a reversible roller table 51 ft. long, which is driven by a 50 hp., 550 rpm., d-c. motor. Speed of this table is about 440 feet per minute. No. 3 rougher is a four-high 34 in. and 53 in. by 80 in. universal type stand, as is also No. 4 rougher, which is 87 feet beyond No. 3, both having vertical edging rolls mounted on the entry side. Each of these two roughing mills is driven,

Operators of the mill control operations from elevated pulpits, and communicate with workmen on the floor through automatic signal systems.



View of strip mill motor-room, showing finishing stand drives and motor-generator sets in foreground, roughing drives in the background.

through a gear set with two 13 ft. 8 in. flywheels (70,300 hp.-seconds energy content), by a 3500 hp., 400 rpm., a-c. induction motor. The edging mills are duplicates of that on the second roughing stand with the exception of the rolls, those on No. 2 being 10½ in. radius cone rolls, on No. 3, 10½ in. radius grooved rolls and on No. 4, 10 in. radius grooved rolls. Both No. 2 and No. 3 stands are equipped with high pressure descaling sprays.

A holding table 147 feet long lies between the roughing and finishing trains. This table is divided into two sections, each driven by two 50 hp., 550-1100 rpm., d-c. motors. It has speeds varying from 108 to 432 feet per minute. On this table strip is cooled to proper finishing temperatures to meet metallurgical requirements. There is no forced cooling apparatus provided on the table, because proper temperatures can be obtained through normal radiation. A rotary crop shear is installed at each end of the table, so that both the front and back ends of strip can be squared off before finishing.

A second scalebreaker, two-high, 25½ in. by 80 in., followed by high pressure descaling sprays and driven by a 500 hp., 600 volt 150/600 rpm., d-c. motor, precedes the finishing train, which is made up of six four-high, 27 in. and 53 in. by 80 in. stands on 18 foot centers. They are each driven by a 600 volt d-c. motor, No. 5 and 6 stand motors being 4500 hp., and 125/250 rpm., No. 7 stand 5000 hp. and 80/160 rpm., No. 8 stand 5000 hp. and 100/200 rpm., No. 9 stand 5000 hp. and 125/250 rpm. and No. 10 stand 2500 hp. and 175/350 rpm. No. 7, 8 and 9 stands are driven direct and No. 5, 6 and 10 through gear sets. Strip speed leaving No. 10 stand reaches a maximum of 2008 feet per minute. Loopers are provided between the finishing stands, each driven through a worm reduction unit by a 200 foot-pound d-c. torque motor. A high pressure spray is provided on the delivery side of No. 10 stand and steam sprays are provided on delivery side of each stand. Tachometers to indicate mill speeds are installed in control stations.

R. D. ABBISS,

Chief Engineer, Edgar Thomson Works

A. L. BILLETER,

Division Superintendent, Flat Products Finishing,

Irvin Works

The screwdown on each stand in the mill, except scalebreakers, is operated by two 75 hp., 500 rpm., d-c. motors equipped with a magnetic clutch and dynamic brake. On No. 1 scalebreaker this screwdown is driven by a 35 hp., 575 rpm., d-c. motor through a cut-out coupling and on No. 2 scalebreaker, by a 15 hp., 725 rpm., d-c. motor through a manually operated clutch. Top roll on all stands has hydraulic roll balance except No. 2 scalebreaker, which has a spring balance. Oil film bearings are used on No. 1 scalebreaker and on all back-up rolls in the four-high hot mill stands. Grease lubricated babbitt bearings are applied on No. 2 scalebreaker, and on the work rolls of the broadside mill. All other work rolls run in roller bearings.

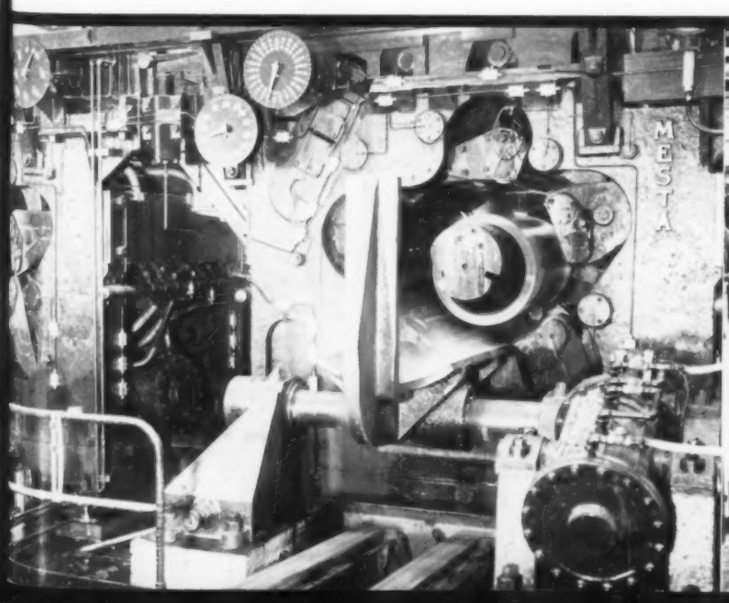
The mill is automatically lubricated by four separate recirculating type oil systems servicing the oil type back-up roll bearings, the pinion stand gears and bearings, and the bearings of the large mill drive motors and motor generator sets. Grease requirements are automatically maintained by several central station greasing systems strategically located throughout the mill.

Hydraulic requirements for the descaling systems are met by three units made up of two 1000 gpm., 1300 lb. pressure pumps driven by a 1250 hp., 6600 volt, 1800 rpm., a-c. motor.

Spaced 11 ft. 9 in. from the last finishing stand is a rotary flying shear designed to cut finished strip up to 77 in. wide and ¼ in. thick into lengths ranging from 16.6 to 33 ft., or it may be used to crop either or both ends of strip that is to be coiled. The shear is driven by twin 150 hp., 450/900 rpm., d-c. motors, controlled hydraulically from No. 10 stand.

After leaving the flying shear, strip passes over a roller table 346 ft. long, having 228 rollers, driven in pairs by 7½ hp., 0/1000 rpm., d-c. motors through twin gears and rubber ball couplings. The table is equipped with cooling sprays both above and below rollers. Two coilers are installed in this table, each driven by five 20 hp., 1200 rpm., d-c. motors. Coils with a maximum width of 77 in., an inside diameter of 30 in. and an outside diameter up to 52 in. can be accommodated. Air operated pushers remove coils from mandrels onto a coil tilter, which places coils on end on a chain con-

Hot strip coilers form coils with a maximum width of 77 in., an inside diameter of 30 in., and an outside diameter up to 52 in.



Continuous pickling facilities include one 80 in. line and one 38 in. line, operating at speeds up to 240 ft. per min.

veyor which carries them to the coil storage building.

If sheets are being cut, they are passed over the coilers onto a 260 foot piler approach table, which has 172 rollers divided into two sections driven in the same manner as the run-out table. The piler is an elevator table having adjustable side and end stops which align the pile, the table lowering as the pile of sheets placed on it increases. As the table reaches its low point, a conveyor engages the bottom of the pile and moves it over against scale arms to be weighed. A crane equipped with a special cradle lifts the pile and carries it to the cooling beds.

Mill speeds, gear ratios, etc., are as follows:

Stand	Gear Ratio	Roll Rpm.	Strip Speed, Ft. per Min.
No. 1 Scalebreaker...	7.5	32	302
No. 1 Rougher.....	7.851	19.12	190
No. 2 Rougher.....	7.5	34.27	341
No. 3 Rougher.....	7.5	53.3	475
No. 4 Rougher.....	7.5	53.3	475
No. 2 Scalebreaker...	9.3	16.1/64.5	107.5/480
No. 5 Finisher.....	4.238	29.5/59	208.5/417
No. 6 Finisher.....	2.571	48.6/97.2	341.7/683.4
No. 7 Finisher.....	Direct	80/160	565.5/1131
No. 8 Finisher.....	Direct	100/200	707/1414
No. 9 Finisher.....	Direct	125/250	883.5/1767
No. 10 Finisher.....	1.232	142/284	1004/2008

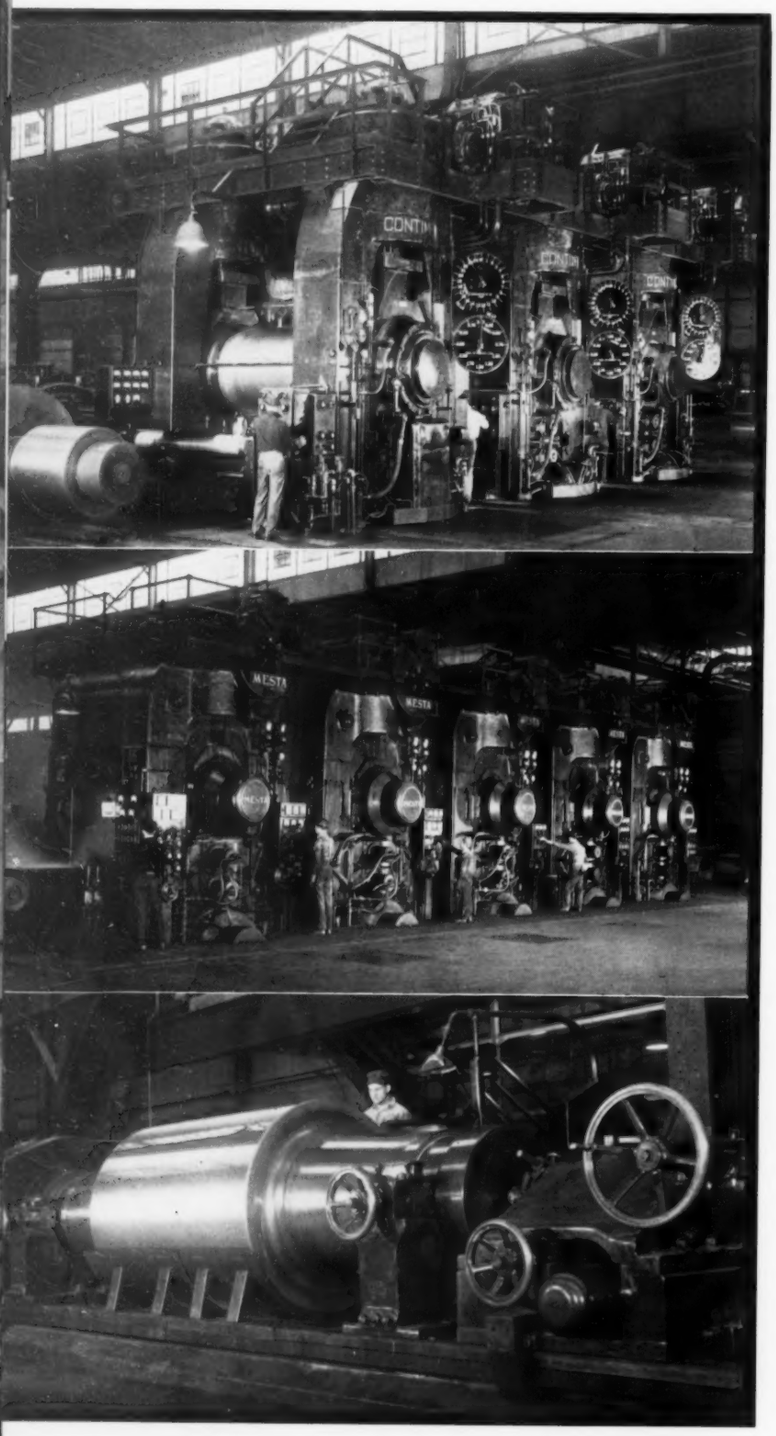
Temperature of the strip is watched carefully throughout its passage in the mill by means of one recording pyrometer and three recording-indicating pyrometers placed at the entry to spreading stand, on the holding table, at the entry to No. 10 stand and at the entry to the coiler.

The hot strip mill building is 94 ft. 9 in. wide by 2520 ft. long and is served by three 60 ton cranes with 15 ton auxiliary hoists and one 25 ton crane, all of 90 ft. span.

A building 84 ft. 9 in. wide by 600 ft. long, conveniently located alongside the hot mill, houses service and roll shops. The latter include two 42 in. roll lathes, two 60 in. roll lathes, two 36 in. roll grinders, one 60 in. roll grinder and special degreasing equipment for cleaning bearings. It is served by a crane of 60 ft. span with 60 ton main hoist and 15 ton auxiliary hoist.

HOT MILL MOTOR ROOM

The hot strip mill motor room, located west of the mill, is 672 ft. long by 64 ft. 9 in. wide and is served by one 60 ton crane with 10 ton auxiliary hoist and having a 60 ft. span. The twelve hot mill drives, with their reduction gears, control equipment, switchgear, etc., are located in this room. The motor room is equipped



Wide strip is cold reduced in a three-stand 84 in. tandem mill at delivery speeds ranging from 456 to 912 ft. per min. *(ABOVE)*

A five-stand 20½ in. and 53 in. x 42 in. tandem mill produces cold reduced strip for tin plate, at speeds up to 1565 ft. per min. *(CENTER)*

Cold mill rolls are kept in condition in a convenient roll shop containing roll grinders and roll blasting equipment. *(LEFT)*

Three electrolytic cleaning lines, with a speed range of 500-800 ft. per min., serve to remove oil and dirt from strip intended for tinning. *(RIGHT)*

Three shearing lines, handling strip 18-72 in. wide at speeds of 150-450 ft. per min., afford an annual capacity of 112,000 tons. *(CENTER)*

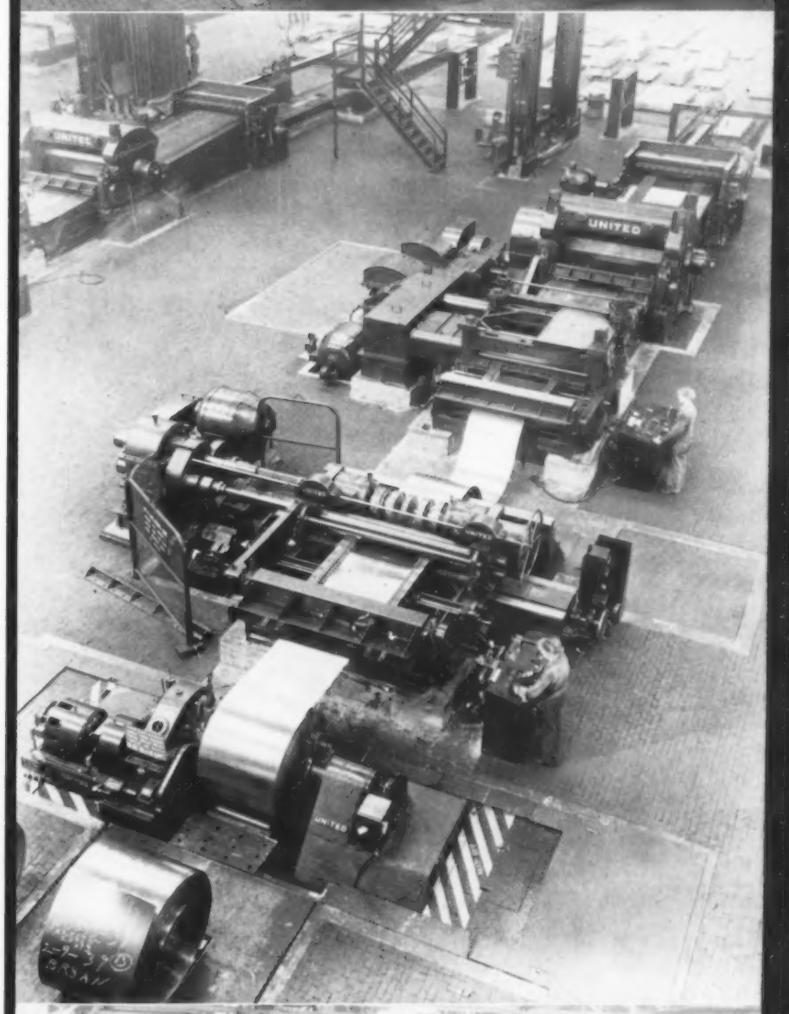
All annealing is effected in portable radiant tube covers of various design. A total of 45 covers and 163 bases are installed. *(BELOW)*

with a recirculating type ventilating system forcing air through coolers located in the motor room basement into the motor room proper. All make up air is filtered before distribution. The ventilating system is designed to handle 525,000 cubic feet of air at 95 degrees F.

Power is supplied from the outdoor substation via a metal clad bus system at 6600 volts to the switchboard

A. H. WERNER,

Superintendent of Hot Strip Mill, Irvin Works



and is distributed to equipment through conduit laid in the concrete floor. Variable voltage direct current is supplied to the main motors driving the finishing train from three 3-unit, 7000 kw., 600 volt synchronous motor-generator sets, each consisting of two 3500 kw., 600 volt, d-c., generators driven at 360 rpm. by an 8100 kva., 6600 volt synchronous motor. Two 5-unit motor-generator sets, each consisting of four 300 kw., d-c., generators driven by a 1250 hp., 6600 volt, 1200 rpm. motor. From these sets, two generators are normally allotted to flying shear service, three to the three runout table sections between the flying shear and coilers, and two for the two coilers or the last two sections of the runout table, depending on whether strip is being coiled or sheared. The eighth generator is a spare which can be switched into any of the other services.

Auxiliary d c. power is provided by two 1500 kw., 250 volt motor-generator sets. Other equipment in the hot mill motor room includes two 25 kw., 0-75 volt looper sets, a 10 kw. battery charging set, seven .72 kw. series exciter sets, and two four-unit exciter sets. There are also two air compressors installed in this room.

CONTINUOUS PICKLING

Coils from the hot mill are stored in two raw coil storage buildings, one being 672 ft. long by 29 ft. 4 in. wide, served by a 15 ton crane of 25 foot span, and the other 888 ft. long by 124 ft. 9 in. wide, served by three 20 ton cranes of 120 foot span. Coils are delivered to either of these buildings from the hot mill over a 1274 ft. chain type conveyor. Coils are transferred by crane from storage to the continuous pickling lines at the south end of the building.

The two continuous pickling lines (one 80 in. and one 38 in.) are located in the pickling building, which is 124 ft. 6 in. wide by 616 ft. 3 in. long and is served by one 20 ton crane with 120 foot span. This building runs east and west and at right angles to the raw coil storage building and cold reduction department. The two continuous pickling lines are of similar construction. The 80 in. line is designed to handle strip up to 72 in. finished width, and has an annual capacity of 270,000 net tons. A combination processing uncoiler and roller leveler is provided at the entry end in which the strip is bent sharply over a small diameter roller as it leaves the coil to crack the hot mill scale and to prepare the surface for rapid cleaning. The strip feeds forward through the leveler to an upcut shear and to an electric seam welder, or, if desired, to a stitcher, where the leading end of a new coil is attached to the trailing end of the coil going through the pickling line.

Pinch rolls take the strip on through the line, consisting of four steel rubber-lined, brick-faced acid tanks, a hot and cold water rinse and a drier. Looper pits at both ends of the line permit the strip to move continuously through the acid tanks, while welds or stitches are being made or cut out, thus avoiding uneven pickling. After the looper pit on the delivery end comes an upcut shear for removing the welds or stitches. An oiling machine and a recoiler are provided at the end of the line, and the coil is then weighed and delivered to a pickled coil storage building by a gravity roller conveyor of the trough type. A solution of sulphuric acid is used in the pickling tanks. The line is designed to operate at a maximum speed of 240 feet per minute. Recording pyrometers keep a record of bath temperatures and automatic controls are provided to hold them within plus or minus 10 degrees F. The details of the 38 in. line are the same as those of the 80 in. line, except that a welder is not provided. The acid tanks are made of steel plates welded together and lined with rubber and brick set in acid-resisting bond. The overall length of the lines is about 540 feet.

COLD REDUCTION

The cold reduction department is housed in a building 912 ft. long by 124 ft. 9 in. wide, and served by one 60 ton crane with 15 ton auxiliary and one 30 ton crane with 10 ton auxiliary hoist, both having a 120 foot span.

A. C. BLEDSOE,

Superintendent of Cold Reduction, Irvin Works

Tin temper mills include one single stand and two two-stand tandem mills, all 18 in. and 42½ in. x 42 in., totaling 140,000 tons annual capacity.
(LEFT)

General view of sheet temper mill department, showing three 4-high 20½ in. and 48 in. x 84 in. single stand mills.
(CENTER)

Tinplate material is cut up on six continuous cut-up lines composed of uncoiler, side trimmer, flying shear, and automatic assorter.
(BELOW)

In this department three cold mills are available. The five-stand tandem is a 42 in. mill, and is used for tin or black plate. A 54 in. reversing mill is available for either tin or sheet stock and an 84 in. three-stand tandem mill for sheet stock. All three mills are 4-high.

The reels at each end of the reversing mill will handle coils having a 30 in. inside diameter and outside diameters up to 54 in. A combination roller leveler and

W. A. MARSHALL,

Division Superintendent, Tin Finishing, Irvin Works

W. W. SCHERER,

Superintendent of Maintenance, Irvin Works

feeding device is provided on one side of the mill. The mill is driven by a 3500 hp., 600 volt, 150/300 rpm., d-c. motor through a single reduction gear set. The reels are each driven by a 1750 hp., 600 volt, 150/210 rpm. and 210/525 rpm., d-c. motor through gear sets. Strip is delivered from this mill at speeds ranging from 500 to 1107 feet per minute. Back-up rolls are 53 in. in diameter and work rolls 20½ in. in diameter. Screwdown is a combination triple reduction helical and worm gear type-driven by two 75 hp., 525 rpm., d-c. motors equipped with a magnetic clutch.

Wide strip is cold reduced in the three-stand tandem mill in which No. 1 and 3 stands are driven by 2500 hp., 600 volt, 225/450 rpm., d-c. motors through gear sets and No. 2 stand by a 3500 hp., 600 volt, 175/350 rpm., d-c. motor through a gear set. The tension reel is driven by a 350 hp., 600 volt, 250/750 rpm., d-c. motor through a gear set. Screwdowns are similar to those on the reversing mill. Strip is delivered from this mill at speeds ranging from 456 to 912 feet per minute. Backup rolls are 53 in. in diameter and work rolls 20½ in. in diameter.

Strip for conversion into tin or black plate is cold reduced in the five-stand tandem mill, No. 1 stand of which is driven by a 600 hp., 600 volt, 450/1050 rpm., d-c. motor through a gear reduction set. The other four stands are each driven by a 1500 hp., 600 volt, 350/790 rpm., d-c. motor through a gear reduction set. Tension reel is driven by a 300 hp., 600 volt, 300/1350 rpm., d-c. motor through a gear reduction set. Screwdowns on each stand are driven by twin 35 hp., 230 volt, d-c. motors equipped with magnetic clutch. Strip is delivered from this mill at speeds ranging from 694 to 1565 feet per minute. Backup rolls are 53 in. in diameter and work rolls 20½ in. in diameter.

Grease lubricated roller bearings are used on work rolls on all three mills, while oil film bearings are used on the backup roll bearings. Backup rolls are hydraulically balanced, roll changes being effected with devices of special design. Work rolls on these mills are changed by means of a counterweighted rig. Provisions for furnishing roll and strip coolants include separate oil circulating systems for each of the cold reduction units. The five-stand mill is provided with an exhaust system for removing vapor rising from the roll and strip coolant.

Power for the reversing mill is furnished by a 4000 kw. motor generator set, while a 7000 kw. set supplies the current required for the three-stand mill. This equipment, together with a 5000 kw. motor generator set for the five-stand mill, is installed in a special motor room adjacent to the cold reduction department.

Next to the cold reduction department is located the roll and machine shop containing roll grinders and roll

A. J. DIEFENDERFER,

Superintendent, Slabbing Mill,

Edgar Thomson Works

W. F. McGARRITY,

Chief Metallurgist and Inspector, Irvin Works

blasting equipment, necessary to service the three mills in addition to the temper mills. This shop is 648 ft. long by 64 ft. 9 in. wide with a 624 ft. by 30 ft. leanto and is serviced by a 60 ton crane with 15 ton auxiliary and a 30 ton crane with 10 ton auxiliary, both having a 120 foot span.

Three electrolytic cleaning lines, capable of handling 16 in. to 38 in. strip at speeds ranging from 500 to 800 feet per minute are located in the south end of the cold reduction department. These lines are about 180 ft. in overall length. Placed in cone type uncoilers, the strip is fed forward to a spot welder which fastens the leading end to the trailing end of the strip in the line.

From the welder the strip is passed through a hot washer and a set of wringer rolls into the electrolytic tank. This is a single compartment tank with a large floating type roll at either end to bring the strip to the proper sub-surface pass line. In this line the strip, which acts as the cathode, passes through several sections of large surface anodes. Covered sections, in addition to the line tension, maintain the strip at proper pass line and assure proper cleaning of both sides. The tank is divided into two electrical systems, the tank proper being kept out of the circuits. Leaving the electrolytic tank, the strip is passed through a hot water rinse and a set of driven pinch rolls. After going through a looper pit, the strip is recoiled.

Two 75 kw. and one 100 kw. motor generator sets furnish variable voltage current for the motors on the three cleaning lines. Two special motor generator sets supply current at 7500 amperes and up to 16 volts for each line. Each set is driven by a 100 hp. motor.

Located in the north end of the cold reduction building are one recoiling line and three shearing lines to handle a portion of the product from the reversing and three-stand tandem mills. The recoiling line consists of an uncoiler, inspection table, side trimmer and recoiler. It is designed to handle 18 in. to 72 in. finished width material up to No. 11 gauge at the rate of 100 to 300 feet per minute, and has an annual capacity of 60,000 net tons per year. Coils on the entry end have an inside diameter of 30 in. and outside diameter of 54 in. maximum. The inside diameter on the delivery end may be either 24 or 30 in. The three shearing lines

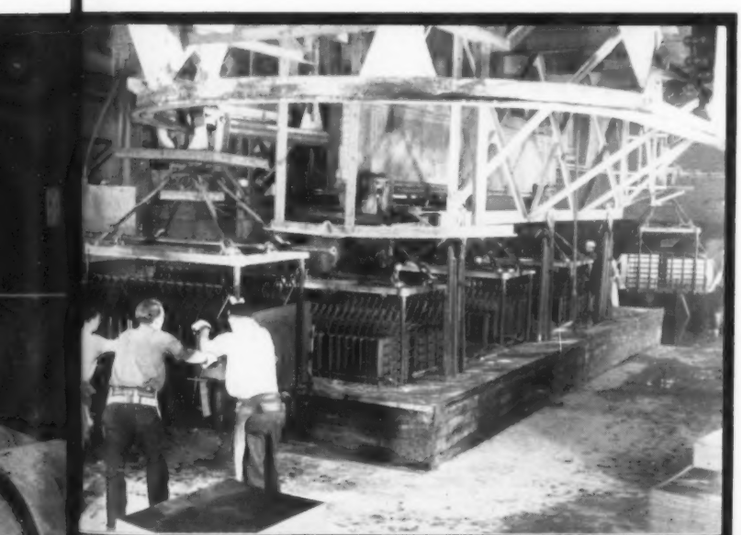
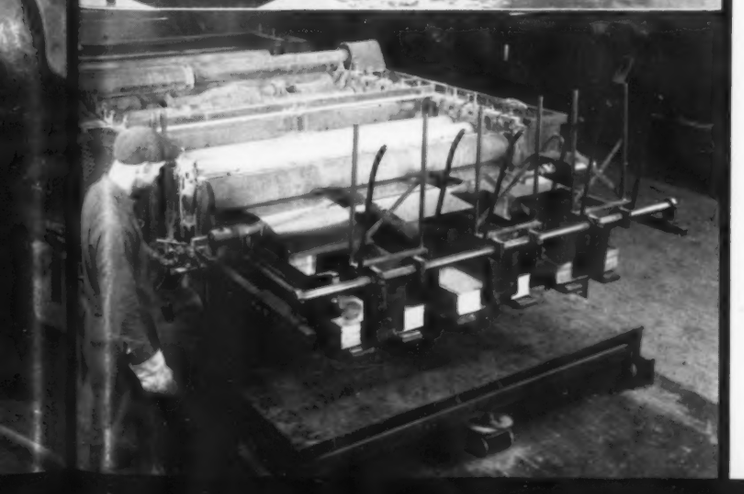


Plate to be tinned passes through the white pickler for a final cleaning, is placed in water boshes and transferred to the tinning department.



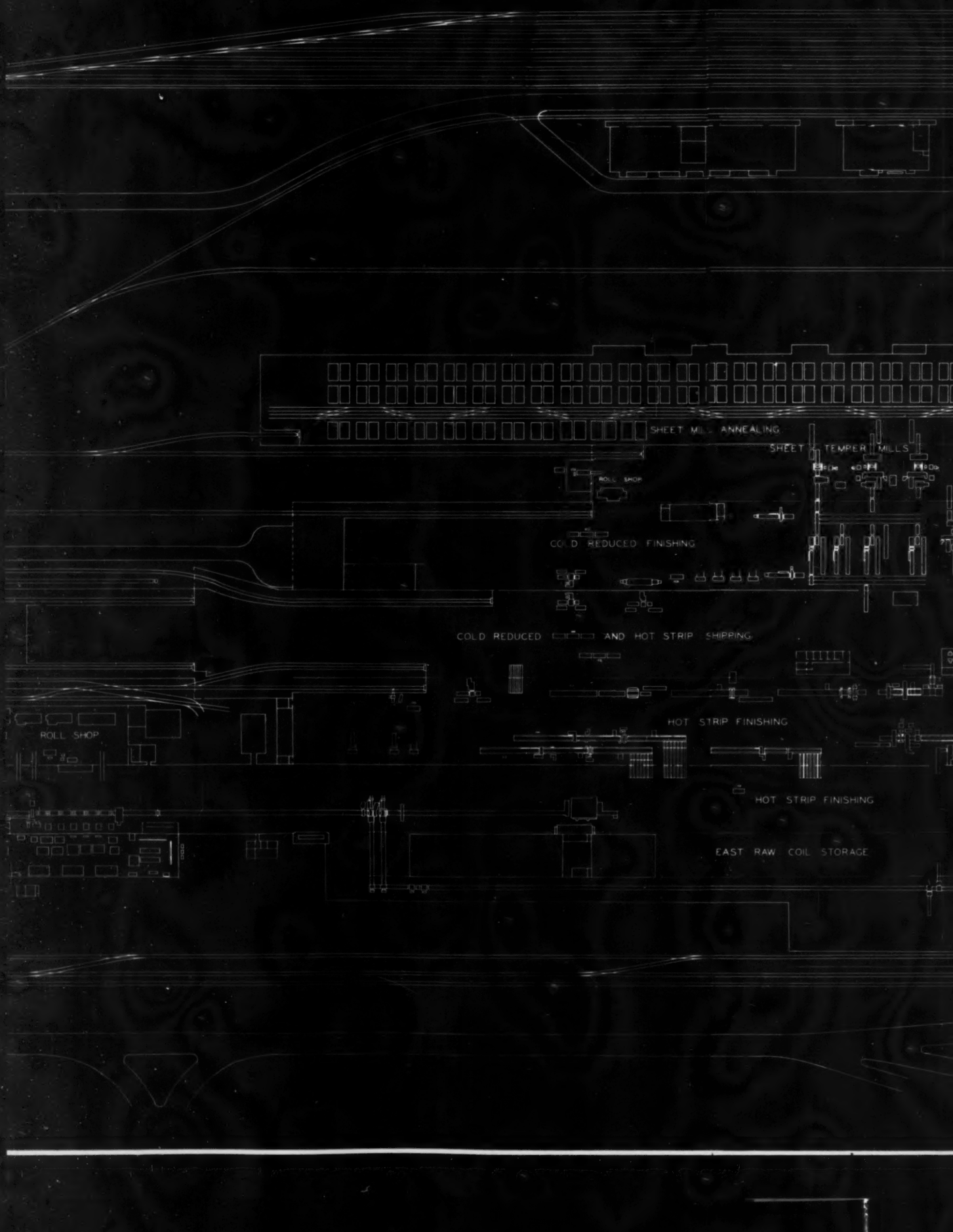
View of the delivery end of 75 in. tinning machine. There are five 75 in. machines and nine 64 in. machines, all with magnetic feeders.

MILL DATA - IRVIN WORKS

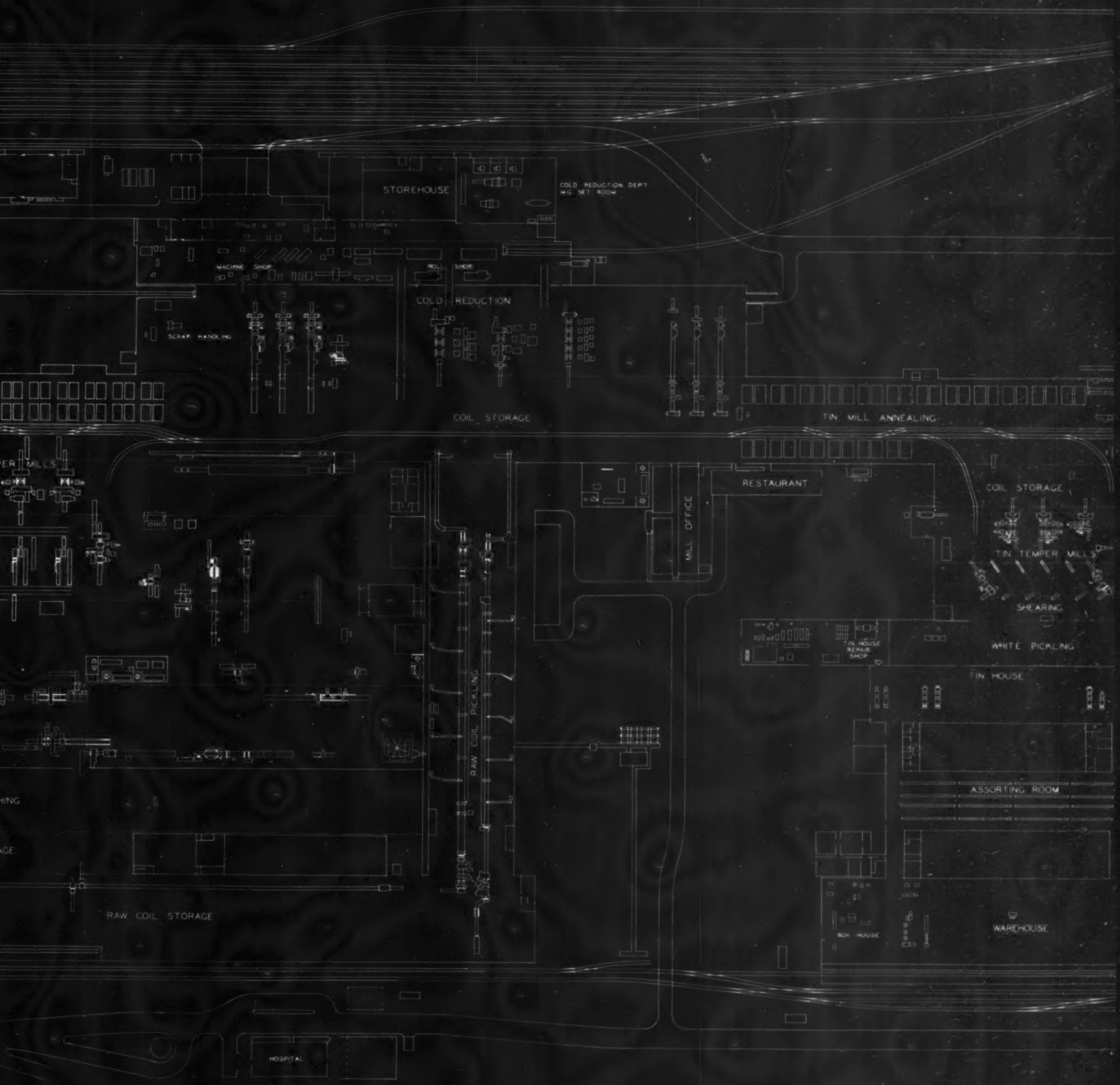
Stand	Characteristics	Diameter: Work Rolls	Diameter: Back-up Rolls	Roll Length	Motor: HP.	Motor: Volts	Motor: RPM.	Motor: Type	Remarks
80" HOT STRIP MILL									
No. 1 Scalebreaker	1-stand, 2-high	36"	....	66"	1250	6600	240	Induction	Geared. Two Flywheels.
No. 1 Roughing	1-stand, 2-high	38"	51"	130"	3500	6600	150	Induction	Geared. Flywheel.
No. 2 Roughing	1-stand, 4-high	38"	51"	80"	3500	6600	257	Induction	Geared. Two Flywheels.
No. 3 Roughing	1-stand, 4-high	34"	53"	80"	3500	6600	400	Induction	Geared. Two Flywheels
No. 4 Roughing	1-stand, 4-high	34"	53"	80"	3500	6600	400	Induction	Geared. Two Flywheels
No. 2 Scalebreaker	1-stand, 2-high	25½"	....	80"	500	600	150/600	d-c.	Geared.
No. 5 Finishing	1-stand, 4-high	27"	53"	80"	4500	600	125/250	d-c.	Geared.
No. 6 Finishing	1-stand, 4-high	27"	53"	80"	4500	600	125/250	d-c.	Geared.
No. 7 Finishing	1-stand, 4-high	27"	53"	80"	5000	600	80/160	d-c.	Direct.
No. 8 Finishing	1-stand, 4-high	27"	53"	80"	5000	600	100/200	d-c.	Direct.
No. 9 Finishing	1-stand, 4-high	27"	53"	80"	5000	600	125/250	d-c.	Direct.
No. 10 Finishing	1-stand, 4-high	27"	53"	80"	2500	600	175/350	d-c.	Geared.
54" REVERSING COLD REDUCTION MILL									
Cold Mill	1-stand, 4-high	20½"	53"	54"	3500	600	150/300	d-c.	Geared. With reels.
84" 3-STAND TANDEM COLD REDUCTION MILL									
No. 1 Stand	1-stand, 4-high	20½"	56"	84"	2500	600	225/450	d-c.	Geared
No. 2 Stand	1-stand, 4-high	20½"	56"	84"	3500	600	175/350	d-c.	Geared With reel.
No. 3 Stand	1-stand, 4-high	20½"	56"	84"	2500	600	225/450	d-c.	Geared
42" 5-STAND TANDEM COLD REDUCTION MILL									
No. 1 Stand	1-stand, 4-high	20½"	53"	42"	600	600	450/1050	d-c.	Geared
No. 2 Stand	1-stand, 4-high	20½"	53"	42"	1500	600	350/790	d-c.	Geared
No. 3 Stand	1-stand, 4-high	20½"	53"	42"	1500	600	350/790	d-c.	Geared With reel.
No. 4 Stand	1-stand, 4-high	20½"	53"	42"	1500	600	350/790	d-c.	Geared
No. 5 Stand	1-stand, 4-high	20½"	53"	42"	1500	600	350/790	d-c.	Geared
TIN TEMPER MILLS									
No. 1 Mill	1-stand, 4-high	18½"	42½"	42"	350	250	500/1250	d-c.	Geared. With reel.
No. 2 Mill	2-stand, 4-high	18½"	42½"	42"	1-200	250	665/1500	d-c.	Geared. With reel.
					1-350	250	500/1250	d-c.	
No. 3 Mill	2-stand, 4-high	18½"	42½"	42"	1-200	250	665/1500	d-c.	Geared. With reel.
					1-350	250	500/1250	d-c.	
SHEET TEMPER MILLS									
No. 1 Mill	1-stand, 4-high	20½"	48"	84"	125	230	450/1200	d-c.	Geared. With reel.
No. 2 Mill	1-stand, 4-high	20½"	48"	84"	215	230	450/1200	d-c.	Geared. With reel.
No. 3 Mill	1-stand, 4-high	20½"	48"	84"	125	230	450/1200	d-c.	Geared.
No. 4 Mill	1-stand, 2-high,	32"	....	84"	125	230	450/1200	d-c.	Geared. With reel.
No. 5 Mill	1-stand, 2-high	32"	....	84"	125	230	450/1200	d-c.	Geared. With reel.
No. 6 Mill	1-stand, 2-high	32"	....	84"	125	230	450/1200	d-c.	Geared.

BOILER HOUSE
ELECTRIC SHOP
MACHINE SHOP
ROLL SHOP
OUTDOOR SUBSTATION
HOT STRIP MILL
SLAB FURNACE NO 3
SLAB FURNACE NO 2
SLAB FURNACE NO
MOTOR ROOM
SLAB STORAGE

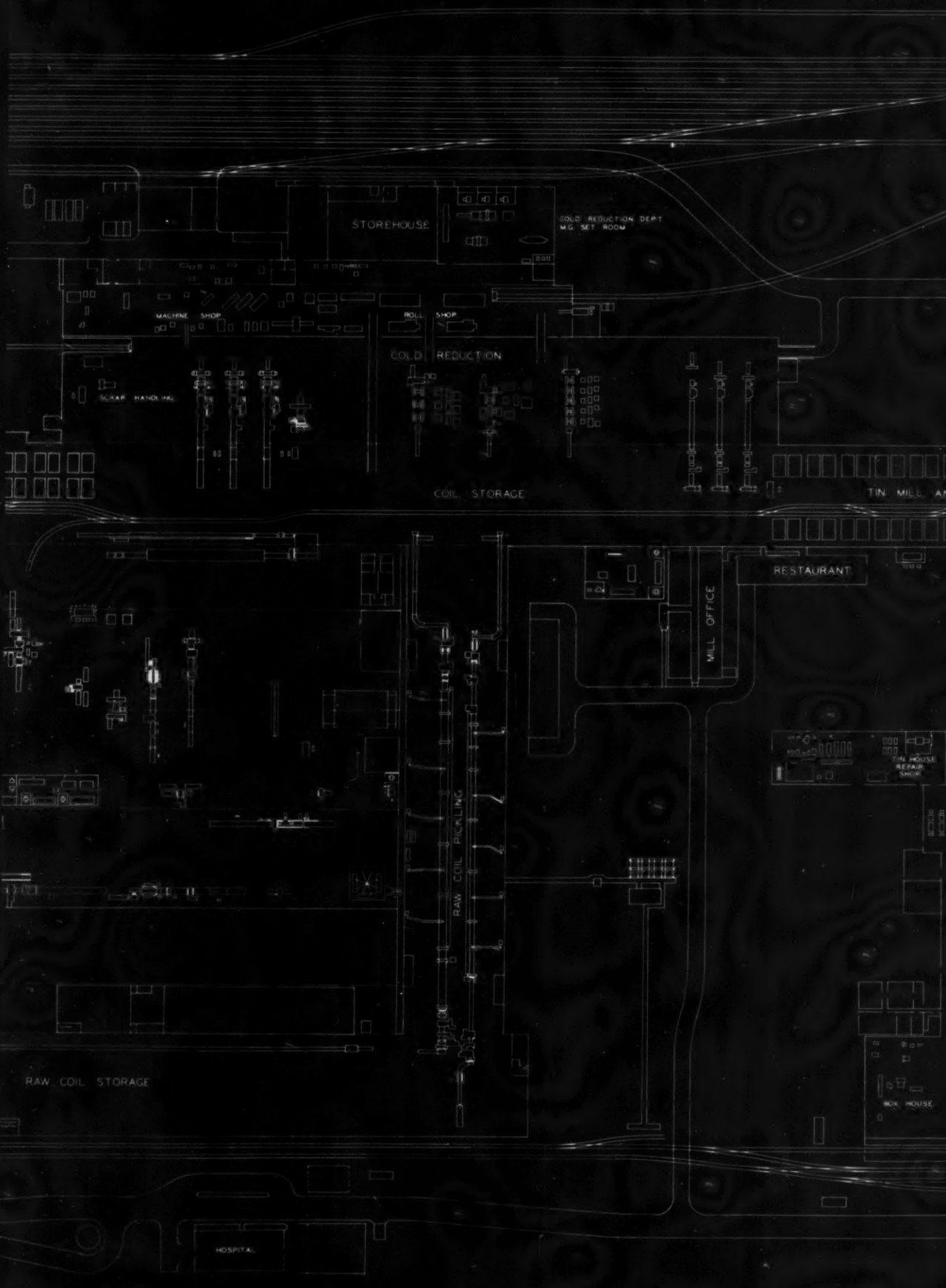
PLAN VIEW IRV



W IRVIN WORKS CARNEGIE-ILLINOIS STEEL CORPORATION



/IN WORKS CARNEGIE-ILLINOIS STEEL CORPORATION



TIN MILL ANNEALING
COIL STORAGE
TIN TEMPER MILLS
SHEARING
BLACK PLATE WAREHOUSE
WHITE PICKLING
TIN MOUSE REPAIR SHOP
TIN HOUSE
ASSORTING ROOM
WAREHOUSE
BOX HOUSE

are designed to handle 18 in. to 72 in. finished width coils up to No. 11 gauge at 150 to 450 feet per minute and will cut material into sheets varying from 30 in. to 180 in. long. Their annual capacity is about 135,000 net tons each.

ANNEALING

The annealing department is housed in a building 2544 ft. long by 124 ft. 9 in. wide and is serviced by three 40 ton cranes with 15 ton auxiliaries, two 20 ton cranes and one 15 ton crane, all having spans of 120 feet. The sheet annealing is located in the north end and the tin annealing in the south end of the building. There are 36 bases and 11 movable furnaces in the tin division. Each base provides room for eight coils and, since they are normally stacked two-high, a total of 16 coils is usually loaded on each base. The heating covers for these bases are provided with three banks of U-shaped tubular heating elements, one being centrally located longitudinally between the coil hoods used to cover the stacks on the base. These elements are

BUILDING AND CRANE DATA

Buildings	Length (Ft.)	Width	Number Cranes	Crane Capacity (Tons)	Span (Ft.)
Slab storage	864	124 ft. 9 in.	3	40/15	120
			2*	7½	40
Hot strip mill	2520	94 ft. 9 in.	3	60/15	90
			1	25	90
Hot strip motor room	672	64 ft. 9 in.	1	60/10	60
Slab furnace building	240	64 ft. 9 in.			
Transfer and passage way	168	64 ft. 9 in.			
Coil transfer	672	29 ft. 4 in.	1	15	25
Raw coil storage No. 1	888	124 ft. 9 in.	3	20	120
Raw coil storage No. 2	480	64 ft. 9 in.			
Raw coil pickling	616¼	124 ft. 6 in.	1	20	120
Hot strip finishing and shipping	1440	124 ft. 9 in.	1	40/15	120
			2	20	120
			1	15	120
Hot strip roll and machine shop	600	84 ft. 9 in.	1	60/15	80
			1	10	80
Boiler house	144	45 ft. 0 in.			
Cold reduced and hot strip finishing and shipping	1896	124 ft. 6 in.	4	15	120
Cold reduced sheet finishing	1440	124 ft. 6 in.	3	15	120
Bright annealing and sheet temper mills	1008	84 ft. 9 in.	1	40/15	80
			1	30/10	80
Sand blasting	72	40 ft. 0 in.			
Annealing	2544	124 ft. 9 in.	3	40/15	120
			2	20	120
			1	15	120
Cold reduction	912	124 ft. 9 in.	1	60/15	120
			1	30/10	120
Roll and machine shop	648	64 ft. 9 in.	1	60/15	60
			1	10	60
Roll and machine shop—Lean-to	624	30 ft. 0 in.			
Cold reduction motor generator set room and store house	336	94 ft. 9 in.	1	20	90
Oil storage	120	60 ft. 9 in.			
Tin temper mill coil storage	288	64 ft. 9 in.	1	10	60
Tin temper mill	288	84 ft. 9 in.	1	30/10	80
Auxiliary motor control	96	64 ft. 9 in.			
Shearing department and black plate warehouse	720	84 ft. 9 in.	2	15	80
Loading building No. 1	264	30 ft. 0 in.			
White pickling	360	64 ft. 9 in.	1	5	60
Tin house repair	216	64 ft. 9 in.	1	5	60
Tin house and miscellaneous building	672	84 ft. 9 in.	2	3	10½
Assorting room	360	84 ft. 9 in.	1	5	80
Box house and warehouse	552	124 ft. 9 in.	2	5	120
Loading building No. 2	552	30 ft. 0 in.			
Mill office and metallurgical laboratory	158	68 ft. 0 in.			

*Gantry cranes.

mounted so that they are free to float at one end. Heat is generated by long diffusion type gas flames within the tubes, the discharge ends being connected to an exhaust system. Provision is made for individual control of each heating element. Coke oven gas is used as a fuel and conditioned natural gas for deoxidizing. In the cold reduced strip division there are two furnaces and six bases of the same type as used in the tin division and, also, 32 furnaces and 121 bases for annealing sheared material. Sixteen of these latter furnaces are equipped with horizontal U-shaped elements similar to those on the tin division furnaces, except that they are of a larger diameter and are located on the sides of the furnaces only. The other sixteen furnaces are equipped with vertical heating elements, each tube having a positive ignition system using a spark plug. In addition to the cold reduction annealing furnaces there is also available an open annealing and normalizing furnace designed to handle 18 to 72 in. finished width material up to 20 feet in length.

T. P. RILEY,

Superintendent, Industrial Relations, Irvin Works

TEMPER MILLS

There are three temper mills provided for tin and black plate products, and six for cold reduced and hot rolled products.

The tin temper mills are housed in a building 288 ft. long and 84 ft. 9 in. wide located adjacent to a coil storage building of the same length and 64 ft. 9 in. in width. The coil storage is served by a 10 ton crane of 60 foot span and the temper mills by a 30 ton crane with 10 ton auxiliary of 80 foot span. There are three temper mills for tinplate, one single stand and two two-stand tandem mills. The single stand mill is driven by a 350 hp., 250 volt, 500/1250 rpm., d-c. motor through a gear reduction set. The tension device is driven by a motor duplicating that on the stand, and the reel is driven by a 90/135 hp., 250 volt, d-c. motor. The first stand on each of the two-stand mills is driven by a 200 hp., 250 volt, 665/1500 rpm., d-c. motor through a gear reduction set, while the motors on the second stands are similar to that on the single stand mill. The

M. W. LEWIS,

Plant Industrial Engineer, Irvin Works

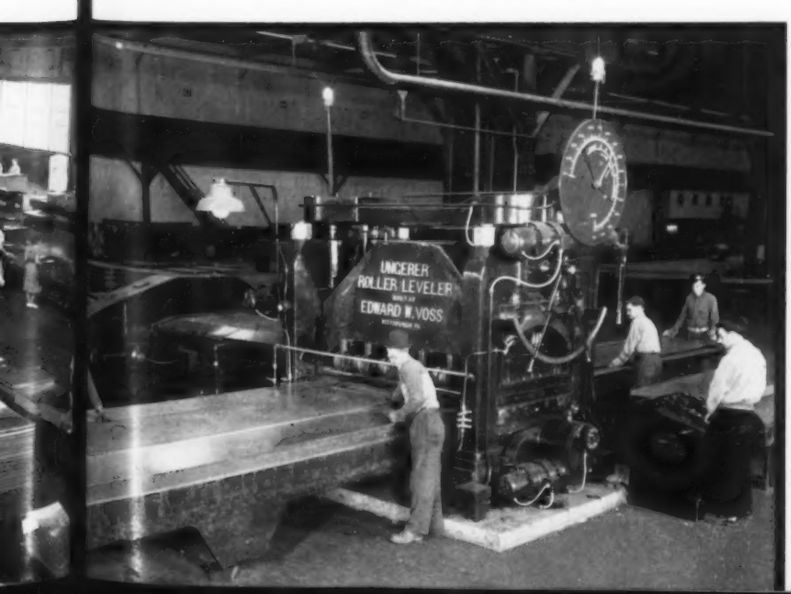
General view of tinplate assorting room, which is 360 ft. long by 84 ft. 9 in. wide.

Tinplate is carefully packed into the conventional boxes and stored in modern warehouses.

tension device and reel on these mills are also similar to that on the single stand mill. Roll sizes are 18 in. and 42½ in. by 42 in. Screwdowns are operated by two 15 hp., 250 volt, d-c. motors. Strip speed on the single stand mill is 600/1500 feet per minute and on the two-stand mills 600/1200 feet per minute. The combined annual capacity of these three units is 192,000 net tons.

Three of the sheet temper mills are four-high mills with 20½ in. and 48 in. by 84 in. rolls, while the other three are two-high mills with 32 in. by 84 in. rolls. All six mills are driven by 125 hp., 230 volt, 450/1200 rpm., d-c. motors through gear reduction sets, and operate at a strip speed of 200/400 feet per minute. Two of the four-high and two of the two-high mills are equipped to temper roll either sheets or coils, the tension reels

The demand for a perfectly flat product is well met by this four-high roller leveler.



being driven by 250/450 hp., 230 volt, d-c. motors The other two mills are equipped to roll only sheets.

Temper mill speeds, gear ratios, etc., are as follows:

Mill	Gear ratio	Roll speed, rpm.	Strip speed, ft. per min.
No. 1 Tin temper mill....	3.20	156/390	735/1839
No. 2 Tin temper mill			
No. 1 stand.....	5.26	126/285	595/1345
No. 2 stand.....	4.00	125/312.5	590/1475
No. 3 Tin temper mill			
No. 1 stand.....	5.26	126/285	595/1345
No. 2 stand.....	4.00	125/312.5	590/1475
No. 1 Sheet temper mill..	12.8	39.1/78.2	200/400
No. 2 Sheet temper mill..	12.8	39.1/78.2	200/400
No. 3 Sheet temper mill..	12.8	39.1/78.2	200/400
No. 4 Sheet temper mill..	20.3	24.6/49.2	200/400
No. 5 Sheet temper mill..	20.3	24.6/49.2	200/400
No. 6 Sheet temper mill..	20.3	24.6/49.2	200/400

No. 1, 2, and 3 sheet temper mills are located in a building 1,008 ft. long by 84 ft. 9 in. wide, serviced by a 40 ton crane with 15 ton auxiliary and a 30 ton crane with 10 ton auxiliary, both with 80 foot spans. No. 4 mill is located in the cold reduced finishing department

As an assurance against subsequent rusting in transit or in storage, sheets may be oiled on this machine.

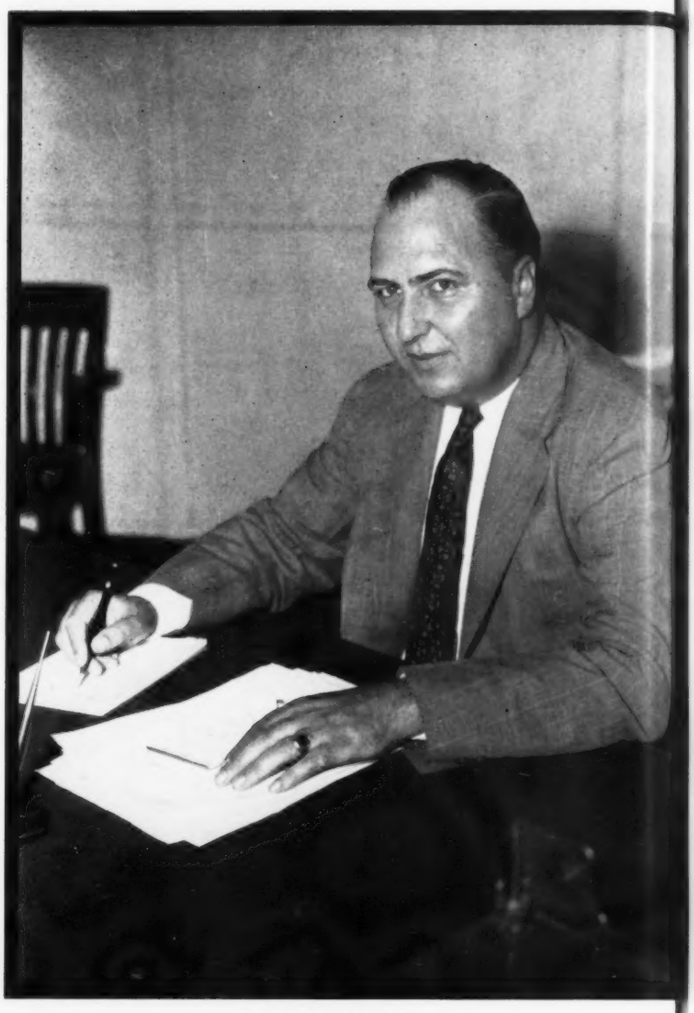
and No. 5 and 6 in the hot strip finishing department. Their annual capacities are as follows:

Mill	Capacity, net tons
No. 1	75,000 (Coil)
No. 2	90,000 (Sheets)
No. 3	90,000 (Sheets)
No. 4	60,000 (Coil)
No. 5	90,000 (Sheets)
No. 6	90,000 (Sheets)

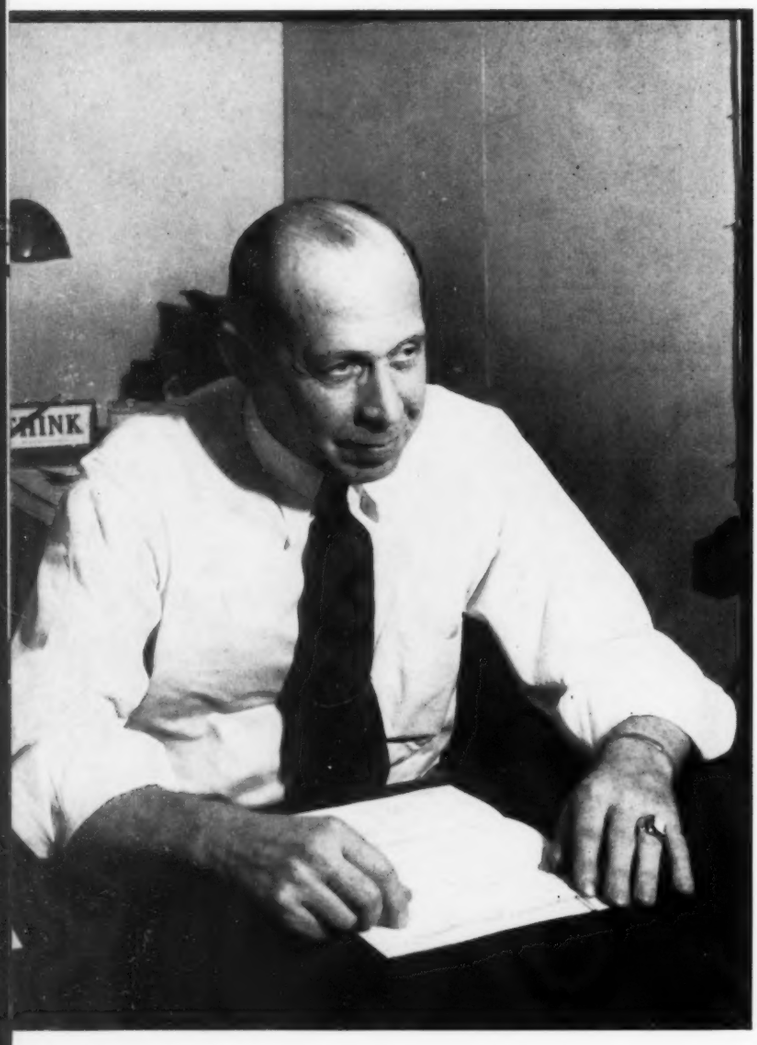
TINPLATE FINISHING

The tin shear lines and black plate warehouse are housed in a building 720 feet long by 84 ft. 9 in. wide and are serviced by two 15 ton cranes with 80 foot spans. There are six shear lines located in the north end of the building, four being equipped with reciprocating type crank shears and the other two with rotary drum shears. The former operate at a maximum strip speed of 350 feet per minute and cut the strip into any desired length between 13 in. and 52 in. The side trimmers may be set to a maximum of 36 in. The other two lines operate at a maximum of 450 feet per minute. Scrap from the side trimmers on all the lines is discharged through a tunnel to a scrap bailer. Material passing through the lines is checked for gauge by flying micrometers, which operate assorting mechanisms on the pilers. The total annual capacity of the six lines is 216,000 net tons.

After being sheared, plate to be tinned is sent to the white pickler for removal of any oxide that may have formed. The pickler is housed in a building adjacent to the shear lines which is 360 feet long by 64 ft. 9 in. wide and is serviced by a five ton crane with 60 foot span. The pickler consists of two acid tanks and a cold water rinse tank under an overhead monorail system. The pickling crates, which are loaded with approximately



J. W. HUMPHREY,
Superintendent of Production and Shipping,
Irvin Works



W. P. MARQUIS,
Works Auditor, Irvin Works

2,400 pounds of sheared plate, are mounted on trolleys running along the overhead rail. After pickling, the plate is placed in portable water boshes and transferred to the tinning department.

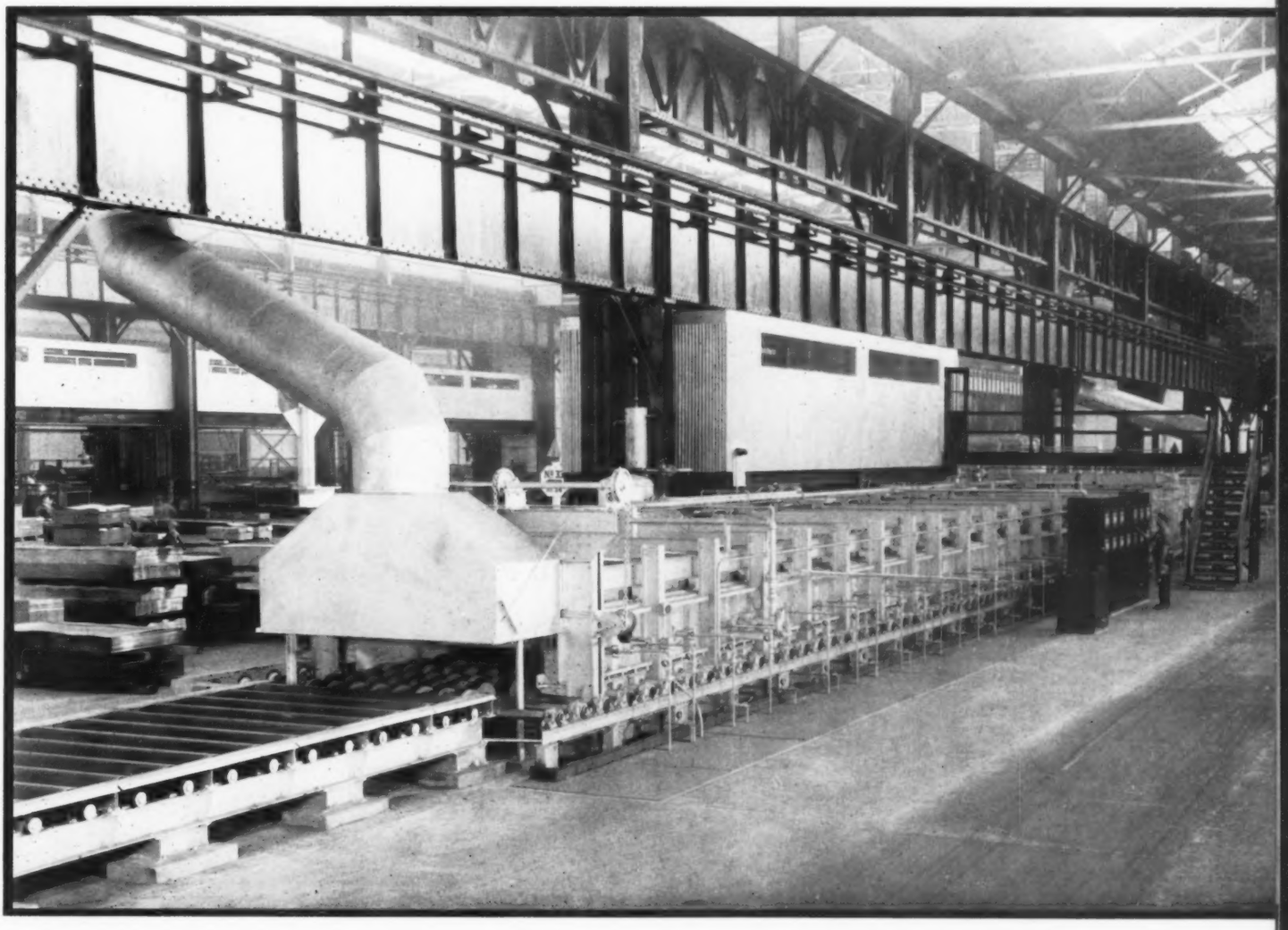
The tin house is 672 ft. long by 84 ft. 9 in. wide and is serviced by two 3 ton underslung cranes with 10.5 foot spans. There are five 75 in. tinning machines and nine 64 in. All machines are equipped with magnetic feeders and are installed in a row down the center of the building. The 75 in. machines can be arranged for either two or three way feeding. As the plates move out of the bosh, a roll type feeder takes them down through the flux into the metal through palm oil to the catcher which delivers the tinned plate to the washer and thence to the branner and piler. The pot is made of heavy steel plate welded construction and individually heated by gas fired submerged elements. Automatic gas and air proportioning equipment is used and they operate under automatic temperature control. A recirculating palm oil system has been installed to insure a constant supply of clean oil at the right temperature, which is controlled thermostatically. Auxiliary roller levelers and a cleaning line are also installed in this department.

The tin plate assorting room is 360 feet long by 84 ft. 9 in. wide, served by a 5 ton crane with 80 foot span, and the tin plate warehouse is 552 ft. long by 124 ft. 9 in. wide, served by two 5 ton cranes with 120 foot span.

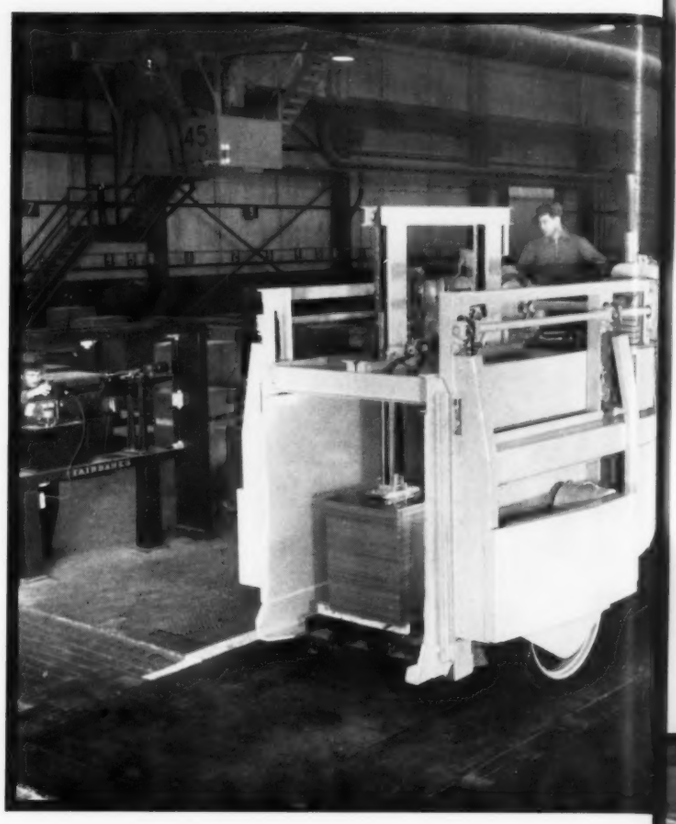
FLAT PRODUCTS FINISHING

Complete facilities for finishing hot rolled strip or sheet are installed in a building adjacent to the hot strip mill and convenient to the raw coil storage. This building is 1,896 ft. long by 124 ft. 6 in. wide and is serviced by four 15 ton cranes with 120 foot spans. This department includes five shear lines, two side- and end-resquaring shear lines, a slitting and recoiling line, two of the temper pass mills and a batch type sheet pickler, scrubbing line, resquaring shears and roller levelers. The slitting and recoiling line, designed to take any hot rolled material up to 77 in. wide, consists of an uncoiler, leveler, side trimmer or slitter, up-cut

A continuous normalizing furnace is available in the hot rolled finishing department for further processing material from the hot mill.



Throughout the plant the most modern type of handling equipment aids the smooth flow of material through the various processing departments.



shear and two up-type recoilers and operates at speeds of 150/450 feet per minute. This unit can handle coils having a 30 in. inside diameter and up to 54 in. outside diameter maximum. On the exit end they may be any inside diameter from 20 up to 30 inches. Annual capacity is 45,000 net tons.

One of the shear lines is designed to take coils from 18 in. to 77 in. wide and 1/8 in. gauge or lighter and cut sheets from 22½ in. to 20 feet in length. This line includes an uncoiler, a combination roller leveler and reciprocating flying shear and a roller leveller. It operates at strip speeds of 150/450 feet per minute and has an annual capacity of 90,000 net tons.

A second shear line handles the same kind of material but has a processing uncoiler, a combination roller leveler and a flying shear, a roller leveler and piler.

Quality of product is keynoted through the entire plant and all items contributing thereto are carefully watched.

Every effort is made in shipping the product to insure against any damage while in transit.

Complementing these lines is a side and end trimmer, discharging through another roller leveler.

Three shear lines are designed to handle multiple length sheets from the hot strip mill. Two of these take full 50 ton packs from the hot mill and convert them into sheets from 30 in. to 16 ft. long. They consist of a transfer conveyor, roller leveler, side trimmer, roller leveler, two adjustable down-cut shears in tandem, gauge table, piler, discharge conveyors and scale. Their annual capacity is 80,000 net tons each and they operate at speeds of 100/300 feet per minute. The other in this group, operating at the same speed, delivers sheets through a roller leveler to a single downcut shear, cutting sheets from 30 in. to 20 ft. long. Motor operated side guards are installed on all three lines. Movable shears are adjusted by motor driven screws.

The four-arm batch type pickler is a 32 in. center-column steam operated unit and will take sheets up to 20 ft. in length. It is provided with two acid tanks and one rinse tank.

A cleaning and scrubbing line is provided, which consists of an acid dip tank, high pressure water spray, alkali tank, scrubber, drier, cooling table, oiling machine, piler and scale. Its capacity is 60,000 net tons per year.

In the cold reduced products division coils from any of the temper pass mills may be cut into finished sheets in a shearing line consisting of a cone type motor driven uncoiler, reciprocating type flying shear, retractable oiler, roller leveler, piler and scale. This shear cuts sheets from 24 to 180 in. in length and up to 72 in. in finished width at speeds of 130/400 feet per minute. Cut stock from the temper mills usually passes through a side and end resquaring line and roller leveler. Additional squaring shears, roller levelers and oiling machines are available in the shipping department. Two 15 ton cranes of 120 ft. span serve the shipping and loading department.

Cut stock from the temper mills usually passes through a side-and end-resquaring line including a roller leveler. Additional squaring shears, roller levelers and oiling machines are available in the shipping department.

Aerial view of Irvin Works, showing the general arrangement of the entire plant.

Where Shutdowns mean TROUBLE!

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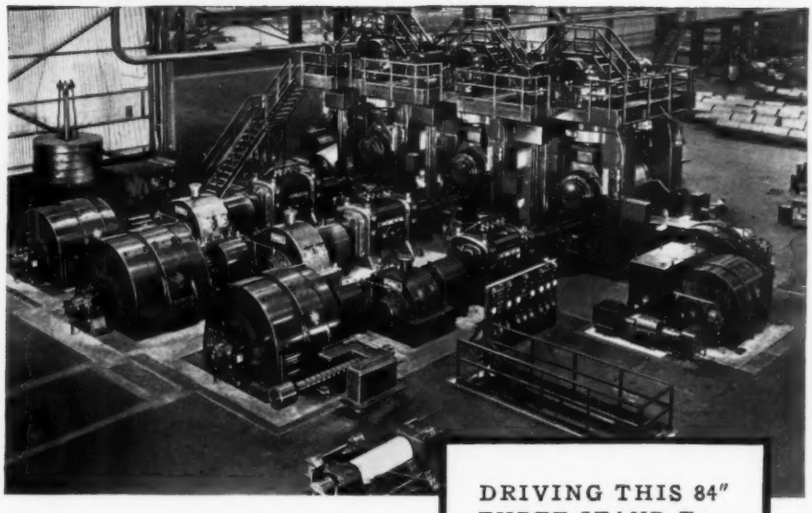
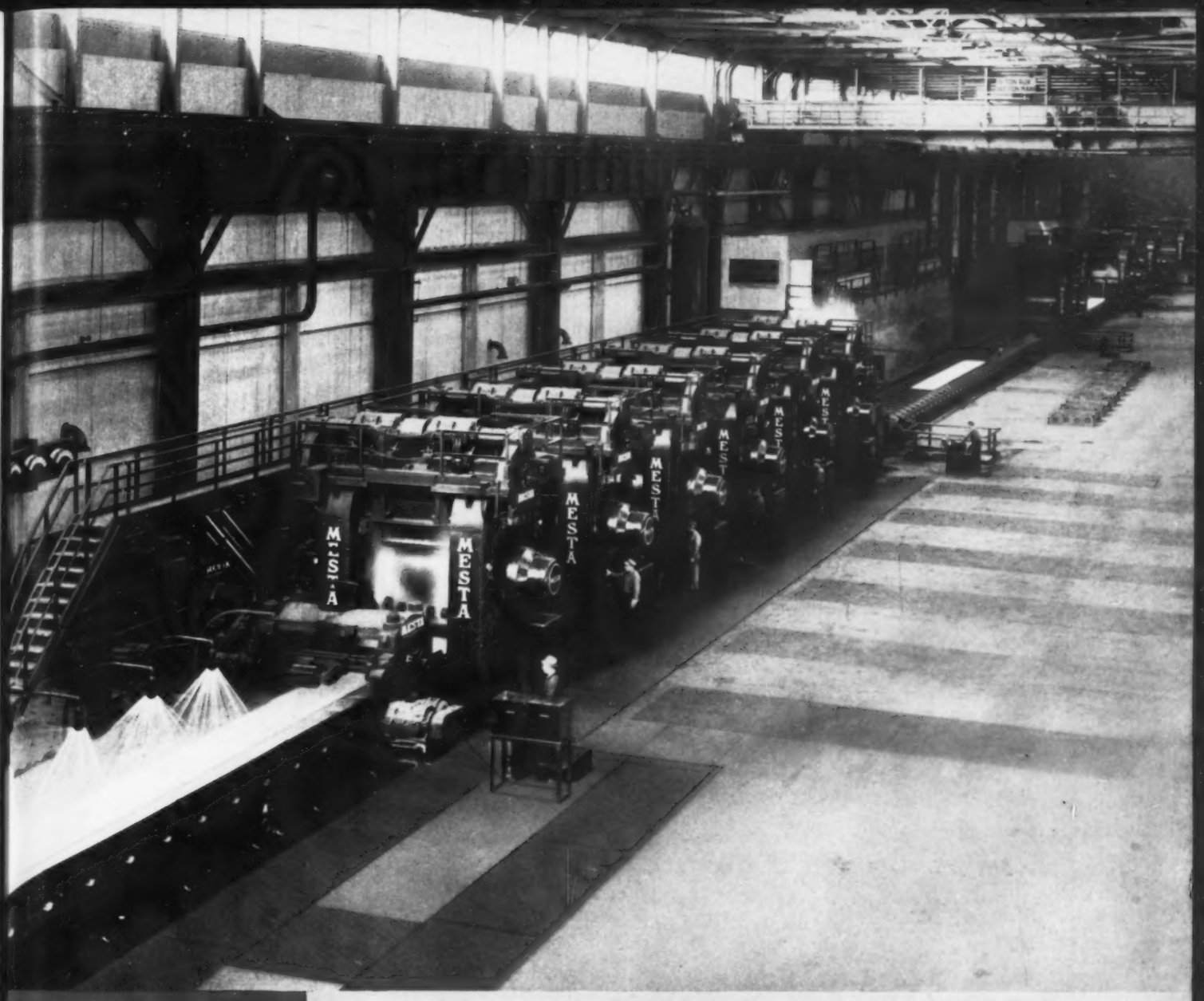
Put 90 years of engineering experience to work for you! There's an Allis-Chalmers engineer . . . well versed in the problems of the steel industry . . . in the district office nearest you. Call him today . . . and find out how you can keep production rolling in your mill . . . with Allis-Chalmers Lo-Maintenance Motors! 1073-B



DRIVING THIS 84" THREE-STAND Tandem Cold Mill are two 2500 hp and one 3500 hp main roll motors and one 800 hp reel motor, supported by a 6-machine 7450 kw motor-generator set—all Allis-Chalmers equipment. This company has found undivided responsibility pays in handling 36,000 pound, 80 inch strips of steel at 900 ft. per minute.

ELECTRICAL DIVISION
ALLIS-CHALMERS
MILWAUKEE · WISCONSIN



MESTA EQUIPMENT

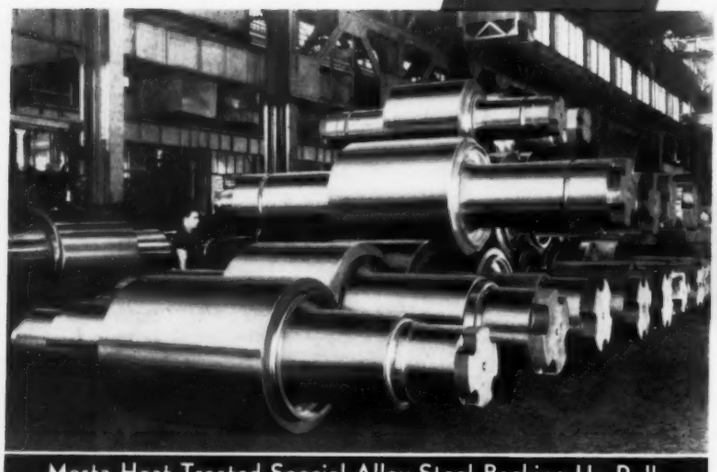
IN CARNEGIE-ILLINOIS STEEL CORPORATION

IRVIN WORKS

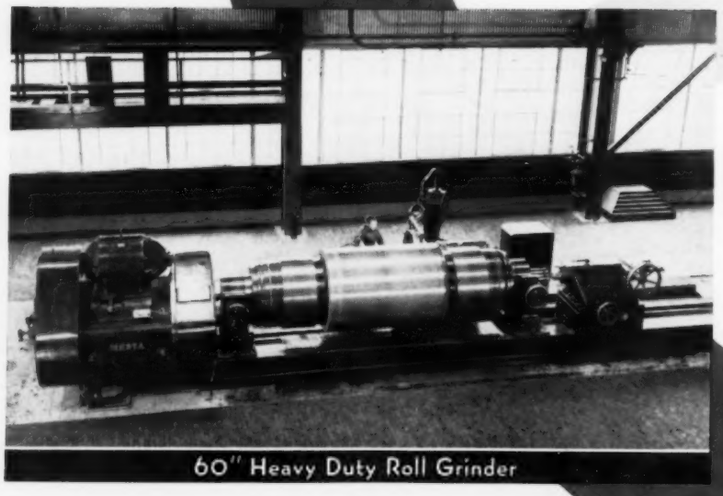
"The Most Modern Mill in the World"

BUILT BY

80" Continuous Four-High Ten Stand Hot Strip Mill



Mesta Heat Treated Special Alloy Steel Backing Up Rolls



60" Heavy Duty Roll Grinder

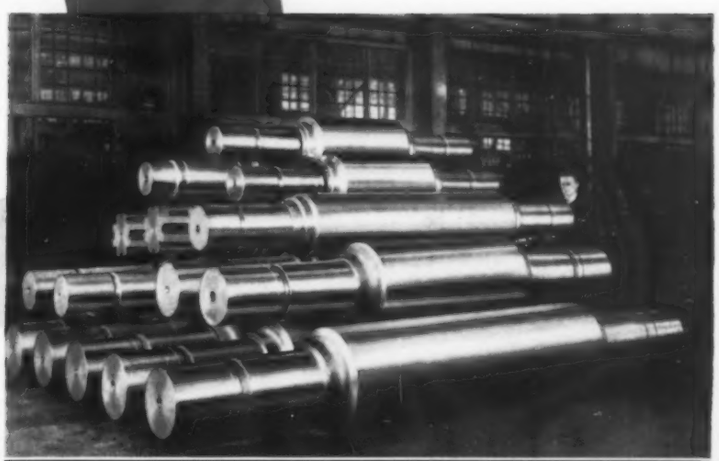
FOR
IRVIN WORKS

Mesta Piler for 80"
Continuous Hot Strip M

MESTA MACHINE COMPANY,

MESTA

42" Five Stand Tandem Cold Mill for Rolling Tin Plate



Mesta Working Rolls for Four-High Hot Mills

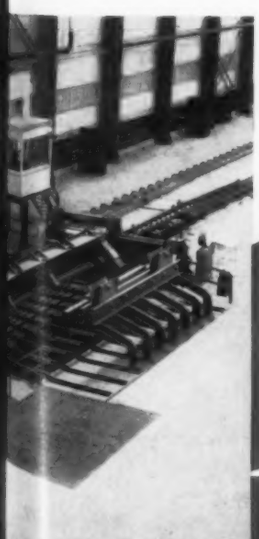
Mesta Patented Four-Arm Pickling Machine

PITTSBURGH, PA., U. S. A.

Mesta Patented
otary Flying Hot Shear

CARNEGIE-ILLINOIS
STEEL CORPORATION

General Offices and Plant
MESTA MACHINE COMPANY
West Homestead, Pittsburgh District



MESTA PRODUCTS

are built in the largest unit plant in the world devoted to the production of ROLLS and STEEL MILL EQUIPMENT

ROLLING MILL MACHINERY

MILLS—Bar, Blooming, Continuous, Merchant, Piercing, Plate, Rail, Sheet, Slabbing, Strip, Structural, Tin Plate, Tire, Tube, Universal, Wheel. Four High (Hot and Cold) Mills

SHEARS—MESTA Patented Rotary Flying, Bar, Bloom, Doubling, Lever, Plate, Squaring, Hydraulic and Steam Hydraulic

Gear Drives, Mill Tables, Manipulators, Saws, Transfers, Trimmers, Slitters, Levellers, Coilers, Flash Welders, Belt Wrappers

MESTA Patented Sheet Chargers

MESTA Tension Reels, Mesta Patented Feed Reels

ROLLS AND MILL PINIONS

ROLLS—Steel and Alloy Steel, Chilled and Sand Iron, Alloy Iron, "Mesta Special" Alloy Steel, Mesta Hardened, Mesta Hardened Chilled, Mesta Forged Hardened Steel

PINIONS—Iron, Steel, Alloy Steel, Cut Tooth and Machine Molded

ROLL LATHES
ROLL GRINDERS
LARGE BORING MILLS
HEAVY-DUTY PLANERS
DRAW-CUT SHAPERS

MESTA Patented Pickling Machines, Continuous Pickling Lines, Electrolytic Pickling

MESTA Electrolytic Cleaning Equipment

MISCELLANEOUS MACHINERY

Cut and Machine Molded Iron and Steel Gears, Flexible Couplings, Hydraulic and Steam Hydraulic Forging, Bending and Forming Presses, Accumulators, Air Compressors, Rope Drives, Large Power Presses, Barometric Condensers, Vacuum Pumps

GAS and STEAM ENGINES, including Una-Flow Type, Mesta Automatic Plate Valves (Iversen Patents)

FORGINGS

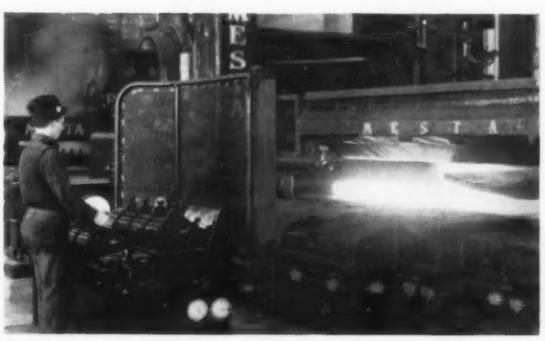
CASTINGS
Iron and Steel

MESTA MACHINE COMPANY,
PITTSBURGH, PA.

POWER *in* PITTSBURGH
grows with Steel

Duquesne Light Co. Construction Crew doing maintenance work on 66 Kv. lines . . . one of the crews that rendered service in New England States hurricane area last year.

IN the Pittsburgh district, the Carnegie-Illinois Steel Corporation has recently completed its new Irvin works, one of the largest and most modern hot strip mills in the entire world. It is completely electrified, and all electric energy is supplied by the Duquesne Light Company making it one of the biggest and most outstanding industrial customers of any utility company anywhere in the country.



Irvin Works 80" Continuous Hot Strip Mill

The Duquesne Light Company takes pride in rendering service to this gigantic industry . . . and particularly in the knowledge that when such a large industrial concern purchases power from a central station, it does so only after thorough consideration of all factors such as . . . cost, reliability, initial investment, future expansion, and flexibility.

DUQUESNE LIGHT COMPANY

Look at all you get

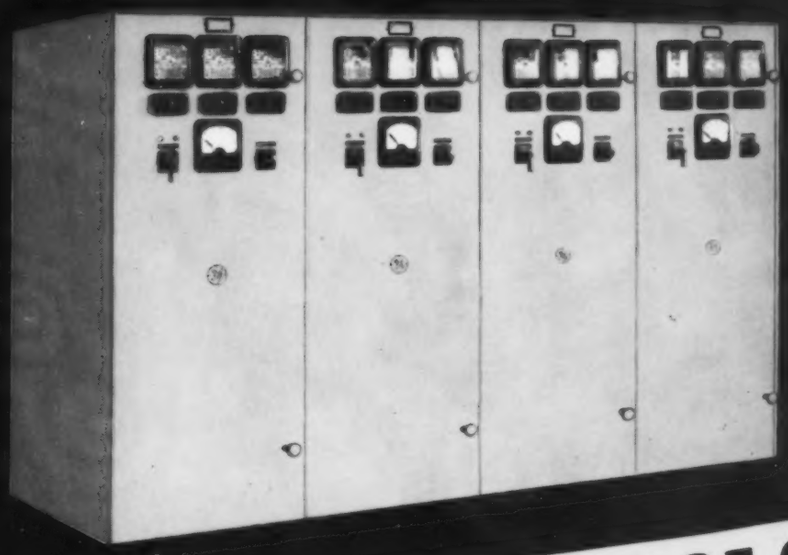
1. Completely metal-enclosed—NO HAZARD TO PERSONNEL
2. Sturdy mechanical interlocks—SAFETY FOR OPERATORS
3. Liberal insulation—SERVICE CONTINUITY
4. Removable breakers—EASY MAINTENANCE
5. Co-ordinated circuit components—BALANCED DESIGN
6. Self-contained control—REDUCED STATION COST
7. Factory-built complete—A TESTED, FINISHED JOB
8. Shipped assembled—LOW, AND PREDICTABLE, INSTALLATION COST

Attractive colors---which harmonize with the station interior, encourage good maintenance, and enhance the prestige of your plant

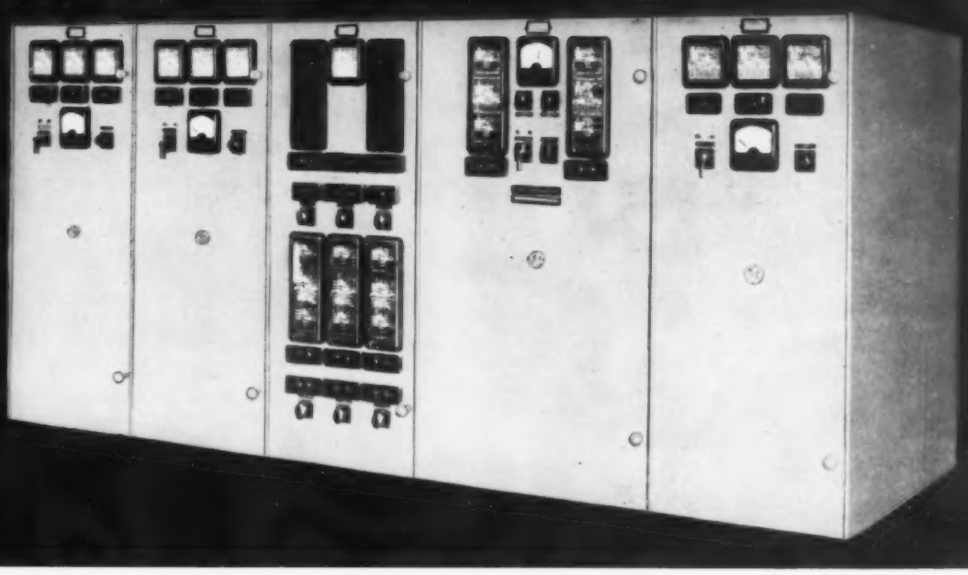
G-E metal-clad—the 100 per cent job for every purpose—with vertical-lift breakers; for service up to 15,000 volts, 500,000-kva interrupting rating. New standard finishes: bronze, blue, cream, and several shades of gray; other colors are also obtainable.

G-E METAL-CLAD SWITCHGEAR *Is Now Available with* EITHER OIL OR AIR BREAKERS

with G-E Metal-clad!



and NOW THE CHOICE OF COLOR

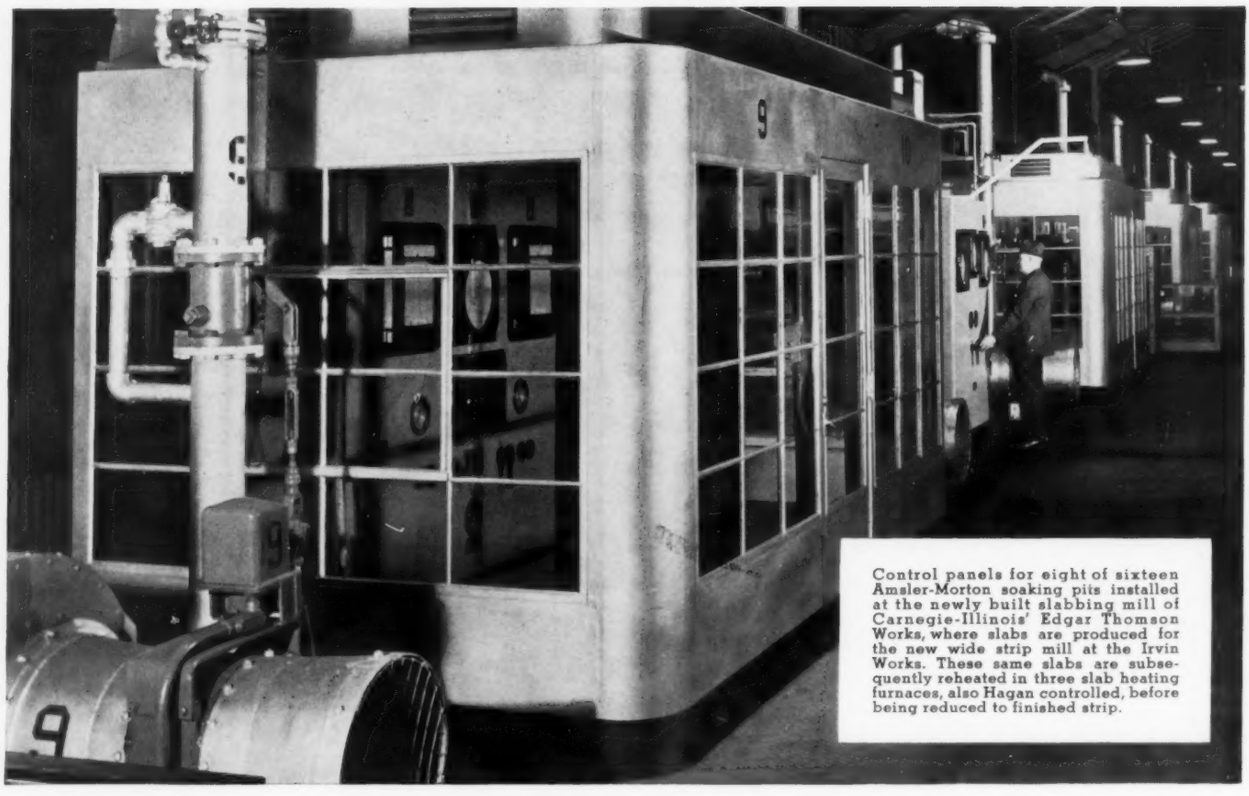


GENERAL ELECTRIC

280-91

Hagan Controlled Heating

HELPS ASSURE TOP QUALITY STEEL AT CARNEGIE-ILLINOIS STEEL CORPORATION FOR IRVIN WORKS



Control panels for eight of sixteen Amsler-Morton soaking pits installed at the newly built slabbing mill of Carnegie-Illinois' Edgar Thomson Works, where slabs are produced for the new wide strip mill at the Irvin Works. These same slabs are subsequently reheated in three slab heating furnaces, also Hagan controlled, before being reduced to finished strip.

Maintains proper furnace atmosphere, temperature and pressure

WHEN customers say, "We want the same uniform quality steel that we had last time," you can duplicate the order more easily if your pits and slab heaters are Hagan controlled.

Accurate automatic control of pressure and the fuel and air ratio assures more uniform heating, higher mill yield, lower fuel costs per ton of ingots heated, better scale condition, freedom from washing and consequently greatly reduced labor and time required for bottom making.

Hagan Control is used on a majority of the soaking pits installed in recent years by many aggressive steel manufacturers. It has proved reliable, simple, extremely accurate, fast in response to slight pressure changes, free from hunting, even under extreme conditions and capable of continuous operation with few adjustments.

Wherever control of pressure, volume, or air-fuel proportioning—those three important variables of steel making—looms as an operating problem, you will find a tried and tested solution in Hagan Automatic Control.

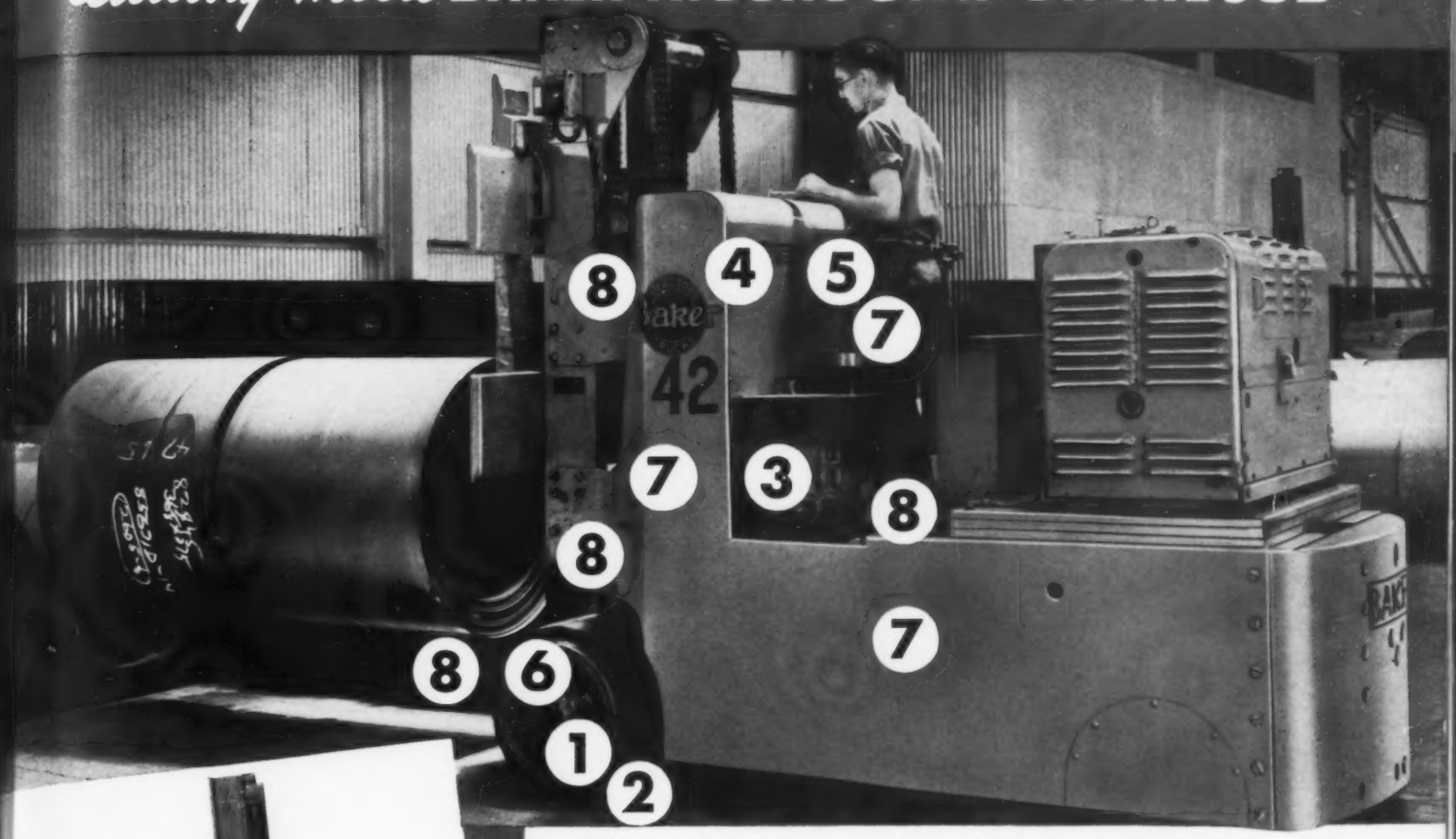
Of the last 95 soaking pits installed and having complete combustion control, 67 are Hagan controlled.

HAGAN CORPORATION · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

At Carnegie-Illinois' Irvin Works—as at other leading mills BAKER TRUCKS STAY ON THE JOB



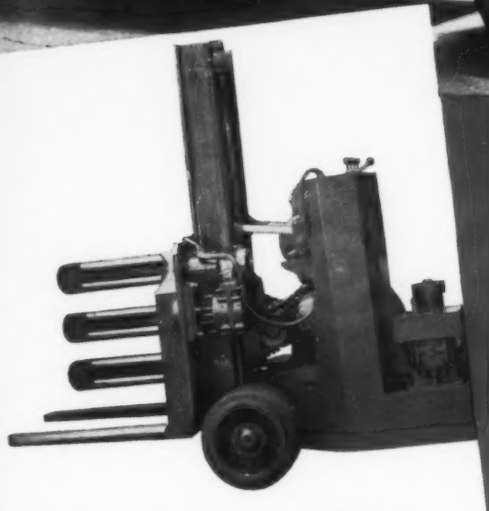
Baker 15,000 lb. capacity ram truck in service at Carnegie-Illinois new Irvin Works.

Carnegie-Illinois uses a fleet of Baker heavy-duty Ram Trucks for handling coils at its new continuous hot strip mill at Irvin. After nearly a year of continuous hard service, they are performing as well as the day they were installed. Similar Baker fleets at other leading steel mills, have a record of trouble-free performance under the most gruelling conditions, for over two years—proving conclusively that Baker Trucks can "take it!" Features illustrated above tell why.

1. The strongest drive axle ever used for industrial trucks. No failures in over 2 years of constant hard use.
2. Tire wear minimized by correct steering design. One fleet of 6 trucks reported no worn-out tires in two years of use.
3. Baker power steer holds trucks in a straight course. Easier to steer, without weaving and wandering.
4. Baker's full contactor control is positive in action and trouble-free. Contact tip replacements easily and quickly made.
5. Baker automatic acceleration means easier handling, and less operator fatigue.
6. Baker's hydraulic wheel brakes have given over 2 years of service without record of failure.
7. No maintenance other than brush adjustment or replacement needed by Baker hoist, tilt or drive motors in 2 years of use.
8. Complete accessibility of Baker units and motors means quick, easy maintenance and repair.

Whether you are handling flat sheets or coils, or any other materials, supplies or finished products, the Baker Material Handling Engineer can help you. Write to

BAKER INDUSTRIAL TRUCK DIVISION
of the Baker-Raulang Company
2166 WEST 25th STREET • CLEVELAND, OHIO



Now Available...

NEW BAKER FORK TRUCK WITH COIL UP-ENDER

Baker heavy-duty fork trucks for steel mills can now be equipped with a coil up-ender, which changes coils from horizontal to vertical or vertical to horizontal positions as desired. Other special adaptations to meet individual requirements.

Trade mark Registered U. S. Pat. Off.

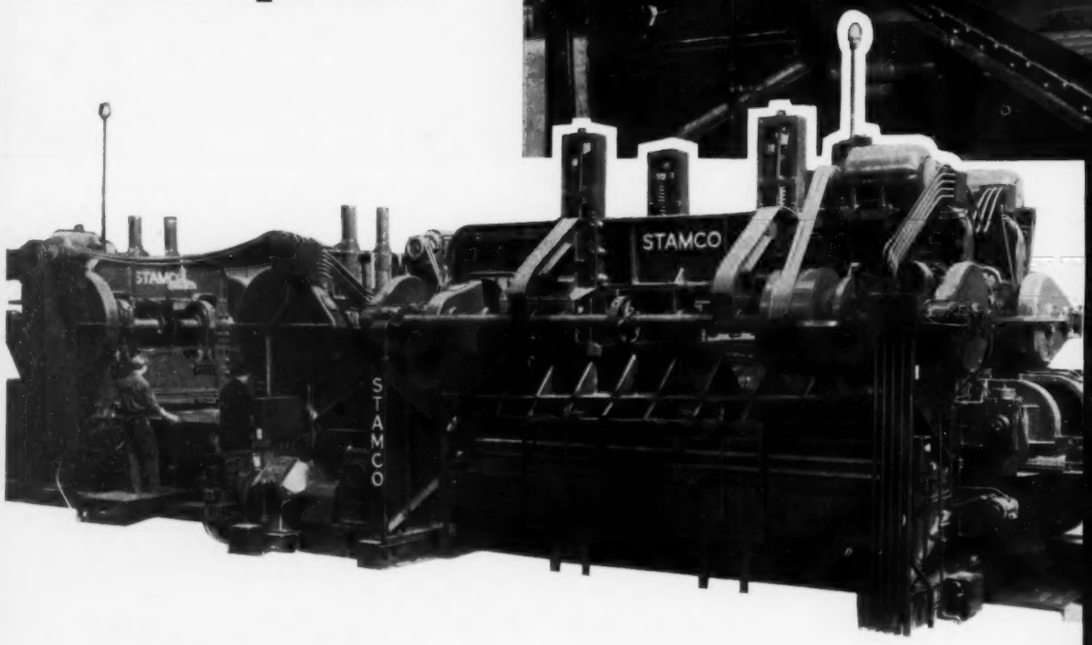
Baker

POWER INDUSTRIAL TRUCKS FOR EVERY PURPOSE

The new

STAMCO
AUTOMATIC SHEAR

Automatic
SHEARS
of all
Descriptions



STAMCO again contributes to the industry's economics with the introduction of its new Automatic Resquaring Unit . . . designed to shear a sheet straight, free from camber, and square to the customer's requirements . . . The machine proper consists of a feed table, two side cut shears equipped with rotary conveyors, two end cut shears equipped with telescoping center table and pinch rolls, delivering the steel to a runout table. The shears are mounted on rails and one shear in each unit is adjustable to the other. The shear is designed in three sizes as for side cutting, 170", 210" and 250" and any practical width.

The **STREINE TOOL & MANUFACTURING COMPANY**

DESIGNERS AND BUILDERS OF STAMCO SHEET AND PLATE MACHINERY

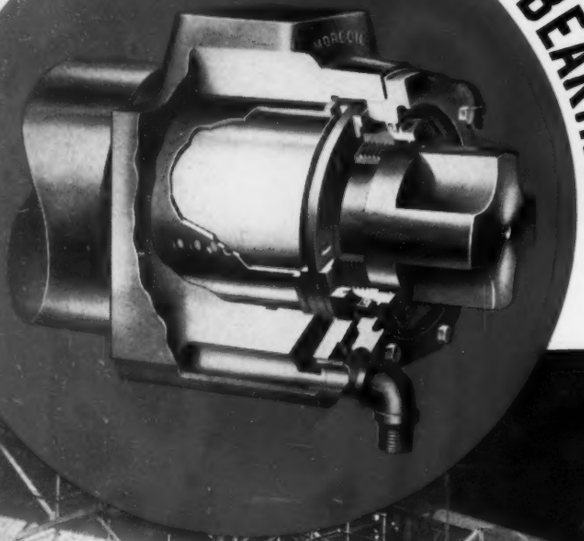
NEW BREMEN, OHIO

One of six Ungerer roller levelers built for the Irvin Works by

Edward W. Voss MACHINERY

BLISS
REVERSING MILL
a 20½" & 53" x 54" 4-Hi Reversing Cold Mill equipped with 44"—90 tapered neck MORGOIL Bearings, capacity 3,110,000 lbs. per bearing.

ROLLING ON MORGOIL BEARINGS



at Carnegie-Illinois

COLD TEMPER PASS MILL
a 20½" & 48" x 84" 4-Hi Cold Temper Pass Mill equipped with 42"—72 tapered neck MORGOIL Bearings, capacity 2,304,000 lbs. per bearing.

Here is further evidence that Morgoils meet all demands of the modern rolling mill for high capacity, low friction bearings. In the many 4-Hi mills at the Irvin Works of the Carnegie Illinois Steel Corporation, Morgoil Roll Neck Bearings carry the load. Millions of pounds ride on a continuous, unbroken film of oil—at high speeds—with dependable accuracy—with savings in power and upkeep. Notably successful is the use of these modern bearings in the big reversing mill—one of the severest tests in the industry.

Whether your problems involve straight rolling or reversing, hot or cold work, let Morgoil Bearings help you save and profit. Send for the Morgoil book.

MORGAN CONSTRUCTION COMPANY
WORCESTER, MASSACHUSETTS, U. S. A.

R-61

MORGOIL BEARINGS

MORGAN
WORCESTER
ENGINEERS AND MANUFACTURERS

37

REPUBLIC METERS MEASURE

Natural Gas . . . Coke Oven Gas . . . Blast Furnace Gas

at the EDGAR THOMSON WORKS

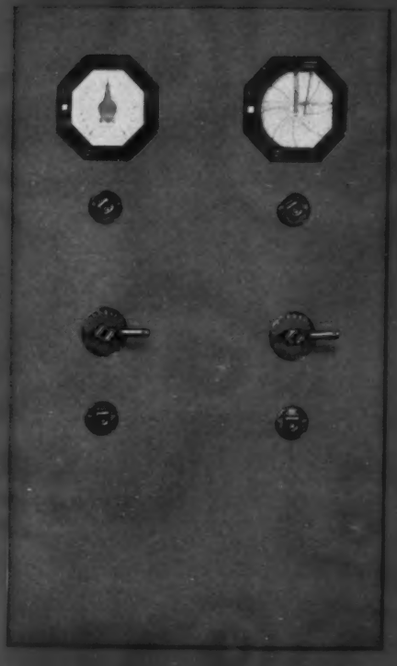
CARNEGIE-ILLINOIS STEEL CORP.

Metering Blast Furnace Gas In 112 Inch Line

One of the largest metered gas lines on record is in the Edgar Thomson Works where a Republic gas meter measures the flow of blast furnace gas to the boiler house through a 112 inch line. Republic gas meters also measure the amount of natural gas and coke oven gas consumed by each of 16 open hearth furnaces. There are 20 other Republic meters which measure the amount of steam, water and air consumed in various parts of the plant.

Republic Panel Type Automatic Control Unit

Republic Panel Type Control Units are built for the automatic control of a single quantity such as furnace pressure, fuel-air ratio, rate of fuel flow, etc., or in combination. The unit illustrated below is for the automatic control of fuel-air ratio and furnace pressure. Supersensitive pressure recorders, flow recorders, fuel-air ratio indicators, etc., are furnished with each panel type control unit as specified.



Designed and built particularly for the control of steel mill furnaces, the Republic Panel Type Control Unit offers several important features. It is easy to install because it is one compact unit. It is easy to operate because all operating adjustments including resetting of the regulator, manual control, etc., can be quickly made from the front of the panel. It is rugged in construction, simple in design and therefore easy to maintain. Write for Bulletin No. 42-39.

Metering The Flow Of Low Pressure Gas

A new Republic meter body, of the ring balance type, has been developed for the measurement of low pressure gases in steel mills. This meter can be used for measuring the flow of gases that contain tar and dirt, such as coke oven gas, blast furnace gas, etc., since the gas does not come in contact with the measuring element. The meter will give full scale reading on differentials as low as 2 in. of water. The reading instruments, indicator, recorder and integrator are of the standard Republic remote reading type. Write for Data Book No. 701-G.

Supersensitive Draft And Pressure Recorders

Republic offers a special line of supersensitive draft and pressure recorders developed expressly for steel mill applications where only extremely small pressure variations can be permitted. These recorders are available with a total chart range as small as — 1/10 to + 1/10 in. of water.

VISIT BOOTH NO. 5 AT THE IRON AND STEEL EXPOSITION

REPUBLIC FLOW METERS CO.

2220 DIVERSEY PKWY. CHICAGO, ILL.

Keeping Pace with Progress

Complete control installation—continuous sheet normalizing furnace.

68 BROWN POTENTIOMETERS PROVIDE

Next to using high-grade materials and skilled workmen—the first essential in the manufacture of Carnegie-Illinois quality sheets—is accurate temperature measurement and positive control of furnace operations.

We are proud of the part entrusted to the 68 Brown Potentiometers installed at the new Irvin Works of Carnegie-Illinois Steel Corporation for the measurement and control of the annealing covers and normalizing furnaces.

The outstanding superiority and unquestioned accuracy of Brown Potentiometer Pyrometers are demonstrated by the large number installed in such plants as Bethlehem Steel Company—American Rolling Mill Company—

BROWN POTENTIOMETERS RECORDING INDICATING CONTROLLING

To Measure and

at THE IRVIN WORKS *of*
CARNEGIE-ILLINOIS STEEL CORPORATION

One of eight panelboards for control of portable annealing covers in sheet mill.

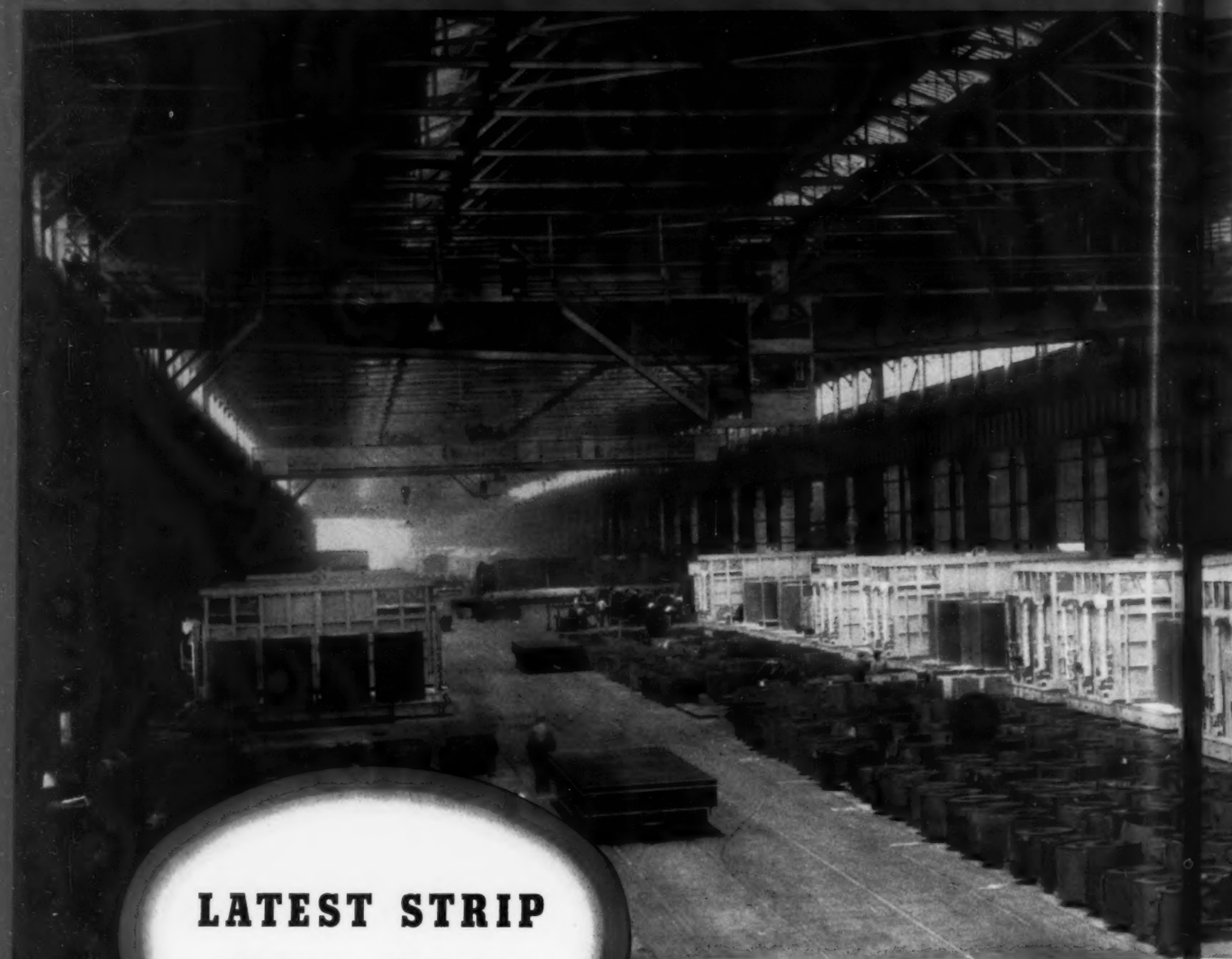
PRECISION MEASUREMENT OF TEMPERATURES

American Steel and Wire Company—Allegheny Ludlum Steel Company—Jones and Laughlin Steel Corporation—Republic Steel Company—and many others. Not only initial installations, but many repeat orders—the best evidence of customer satisfaction.

Write THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4464 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street—Amsterdam-C, Holland: Wijdesteeg 4—Stockholm, 16, Sweden: Nybrokajen 7—England: Wadsworth Road, Perivale, Greensford, Middlesex.

MINNEAPOLIS-HONEYWELL Control Systems

Control is to Economize



LATEST STRIP MILL USES (SC) RADIANT TUBE ANNEALING COVERS FOR TIN PLATE AND STRIP

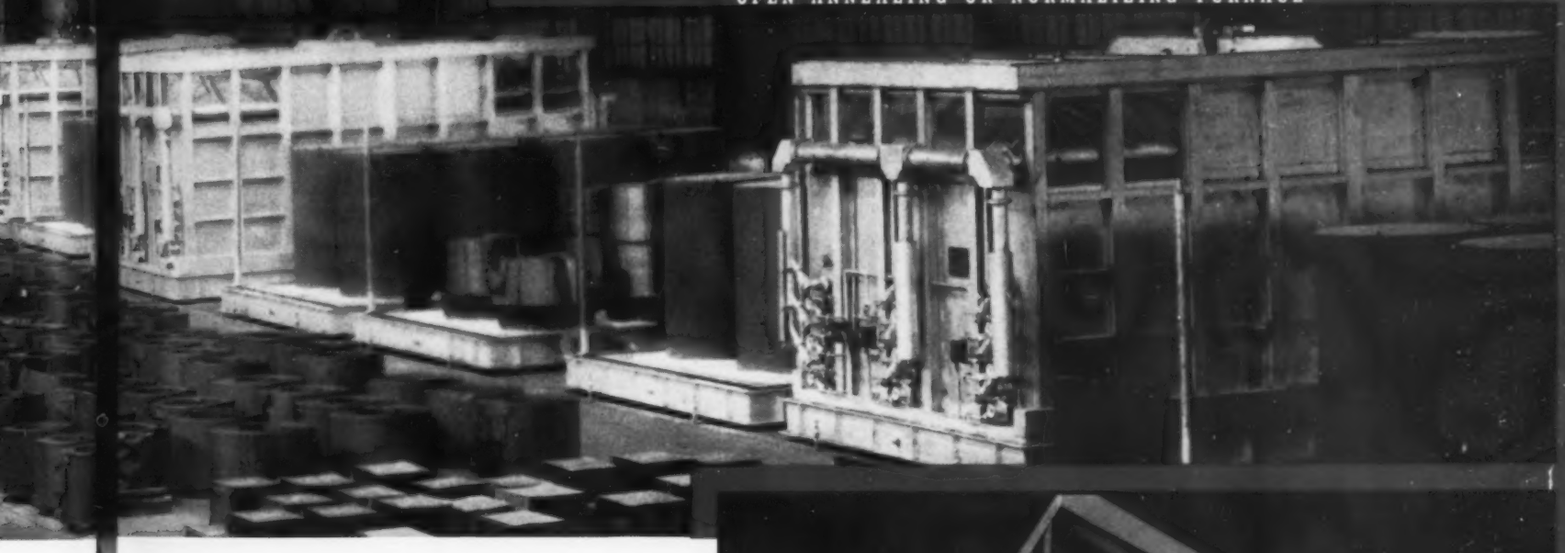
● Just as the old hand mill for rolling sheet steel has rapidly given way to the new continuous strip mill, so, too, is the old method of box annealing giving way to the new and modern method of annealing with radiant tube annealing covers. In a majority of all new continuous strip mills, SC gas-fired radiant tube annealing covers are in use.

It costs less to anneal sheet steel this way because there is less heat loss, greater efficiency of the heat that is used and a more scientific method of applying the heat. It is cleaner*, safer and far more *flexible* in meeting the *variations* of *today's steel mill demands.*

The highest quality of work at the lowest cost per ton annealed is the record hung up by

SURFACE · COMBUSTION · C

OPEN ANNEALING OR NORMALIZING FURNACE



SC annealing covers in every mill where they are used. From top to bottom, from end to end, temperatures may be controlled with exactitude. SC floating tube construction eliminates distortion stress in tubes from expansion under heat, avoiding expensive maintenance and shut-downs. Fuel economy is definitely proved.

Built for sheet, strip, rod and wire, in standard sizes, SC annealing covers are the right answer to increasing annealing capacity, unit by unit, as needed, with a minimum floor space. Ask for booklet "Modern Annealing Practice" describing the various types and applications of SC radiant tube annealing covers.

* Controlled atmosphere required for SC annealing covers is provided inexpensively by DX gas preparation units, built in 500 to 15,000 CFH capacities.

N · CORPORATION

Builders of . . . . . ONE-WAY FIRED SOAKING PITS, BILLET HEATERS, PACK OR PAIR, ANNEALING, CONTROLLED ATMOSPHERE FURNACES and NORMALIZERS

TOLEDO, OHIO

THE LAST WORD IN CRANE EQUIPMENT..

In the Hot Strip Mill are four P&H cranes with 60-Ton main hoist capacity and 15-Ton auxiliary service. Bridge traversing speeds of 550 f.p.m. are combined with double bridge drive to provide rapid acceleration and deceleration.

p&h

ELECTRIC CRANES

In the Box House, this 5-Ton P&H crane is built with cab located in the center so that operator can better spot loads of boxes piled in tiers. It is an 8-wheel crane with horizontal truss girder.

. . FOR CARNEGIE-ILLINOIS' NEW IRVIN WORKS

STEEL makers today—as for many years back—turn to P&H to meet the most exacting service requirements in mill type cranes... Built in accordance with the latest steel mill specifications, the 13 P&H cranes in the new Irvin works have powerful mill-type motors and rapid operating speeds. With magnetic relay controls, the various operations are very easily performed by small masters in front of the operator. End trucks, trolley frames and gear housings are of welded steel construction; shafts and axles are carried in sealed roller bearings. Special attention has been given to prevent the dripping of lubricants... P&H mill type cranes are described in bulletin C-3. To obtain your copy, address the Harnischfeger Corporation, 4455 W. National Ave., Milwaukee, Wis.

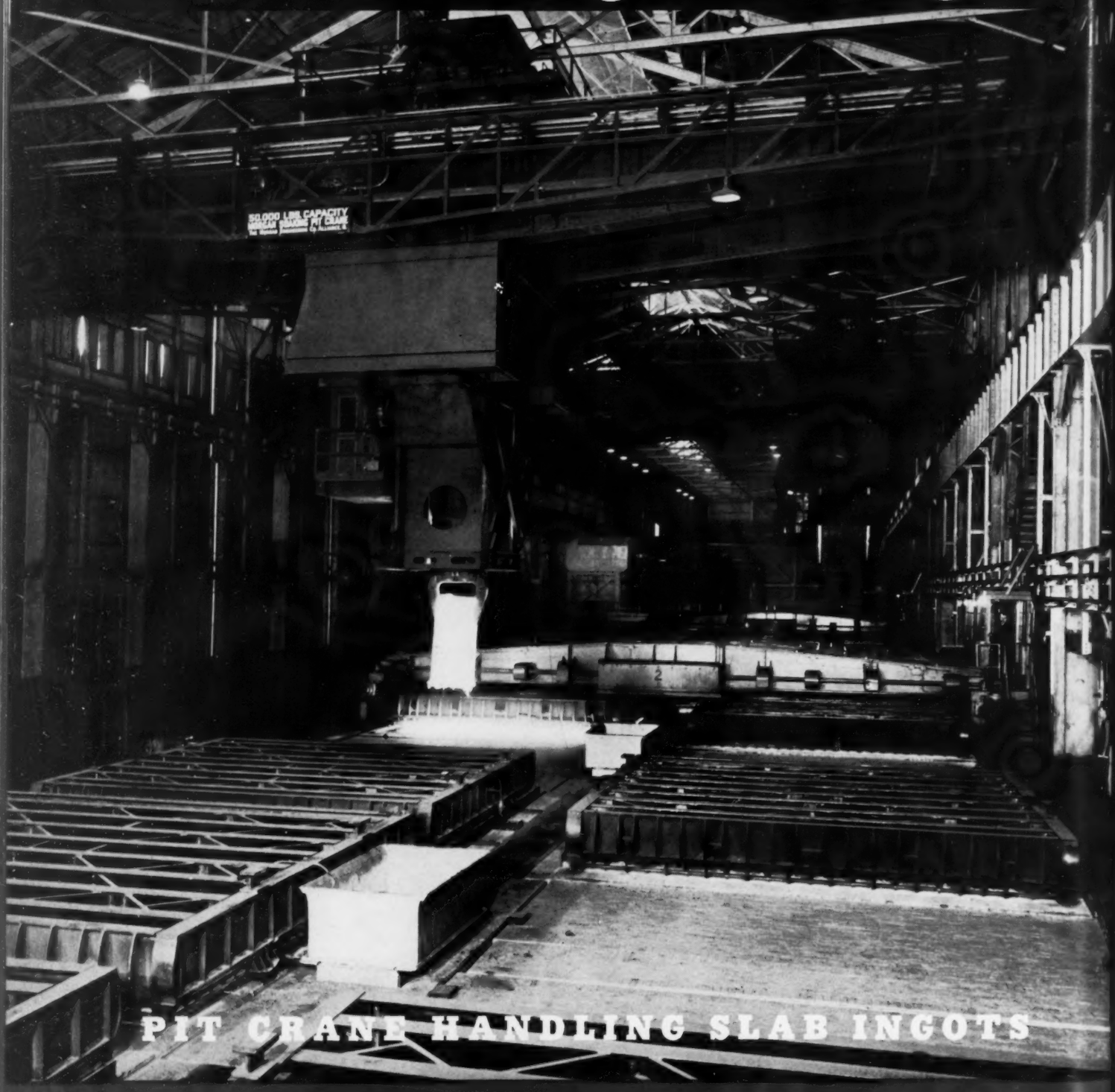
America's Oldest and Only Crane Builder Producing Complete Electrical Crane Equipment

The Cold Rolling Mill is this P&H 60-Ton crane with 15-Ton auxiliary hoist. This crane has an unusually long span of 120 feet; is equipped with double-bridge drive mechanism for fast starting and stopping.

HARNISCHFEGER
CORPORATION

ELECTRIC CRANES • EXCAVATORS • ARC WELDERS P&H HOISTS • WELDING ELECTRODES • MOTORS

BUILT BY MORGAN *Engineering*



PIT CRANE HANDLING SLAB INGOTS

● Illustrated are three Morgan 25-ton, 95'-2" span modern soaking pit cranes handling slab ingots for one of the world's largest strip mills. Equipped with worm-operated trolleys and anti-friction bearings, coupled with Morgan stamina of design and construction, these cranes will render many years of profitable service. Long service life is, of course, based upon sound engineering, the best materials and correct fabrication methods. Morgan soaking pit cranes forty years old, and over, are in successful operation today—slower, less efficient than a modern Morgan crane of latest type as illustrated, but still operating with their original dependability.

★ DESIGNERS • MANUFACTURERS • CONTRACTORS ★
BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
ELECTRIC TRAVELING CRANES • CHARGING MACHINES
INGOT STRIPPING MACHINES • SOAKING PIT CRANES ★
ELECTRIC WELDED FABRICATION • LADLE CRANES
STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS ★

THE MORGAN ENGINEERING CO., Alliance, Ohio
Pittsburgh, 1430 Oliver Building

I-T-E at the NEW IRVIN WORKS

CARNEGIE-ILLINOIS STEEL CORPORATION

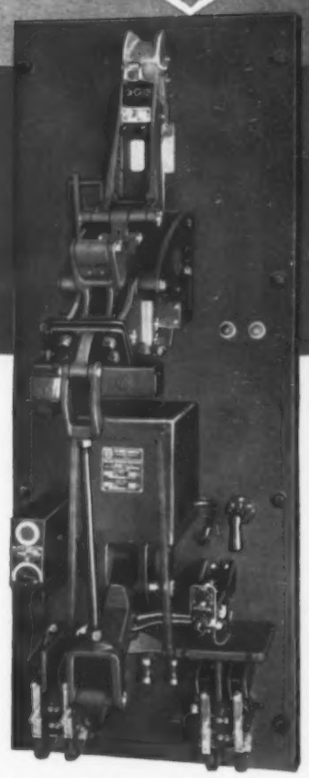
COMPLETE d-c SWITCHING Equipment for FULL-AUTOMATIC SUBSTATION

Of the latest, improved types of equipment used in the new Irvin Works, I-T-E has supplied circuit breakers especially designed for today's steel mill service.

Known as the Type RM, these circuit breakers combine high interrupting capacity with high speed and extremely rugged construction. To fulfill requirements for full-automatic operation, I-T-E supplied reclosing devices arranged to restore circuits at the instant conditions permit. Full protection with minimum outage time.

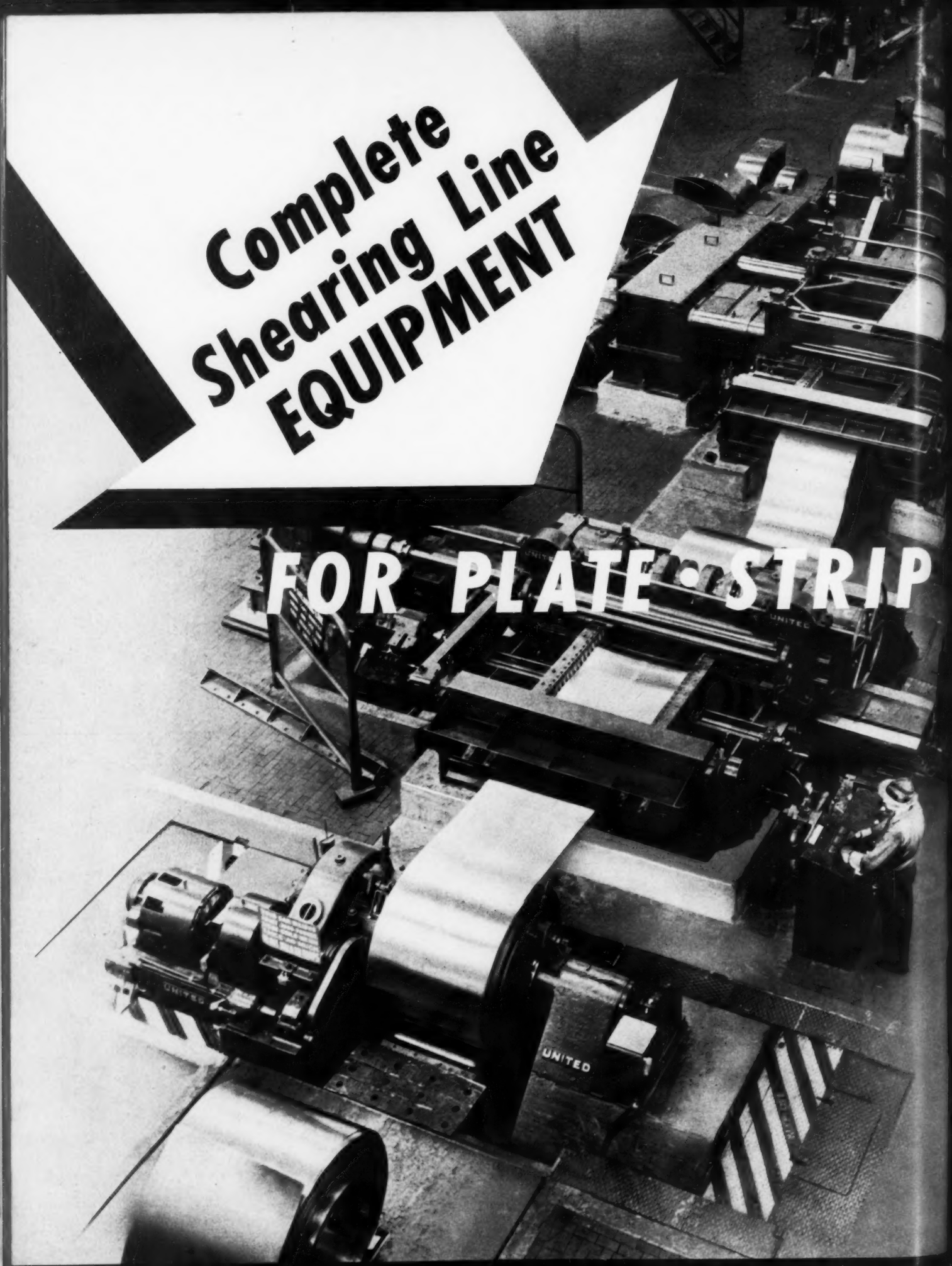
The installation illustrated is that of the d-c switchboard in a full-automatic substation. Included are 13 circuit breakers; 4 protecting positive and negative circuits of 1500 KW, 250-volt generators; 1 tie breaker for paralleling the d-c bus with feeders from other sources of supply; and 8 automatic reclosing feeder circuit breakers of the load-responsive reclosing type.

Representatives in Principal Cities



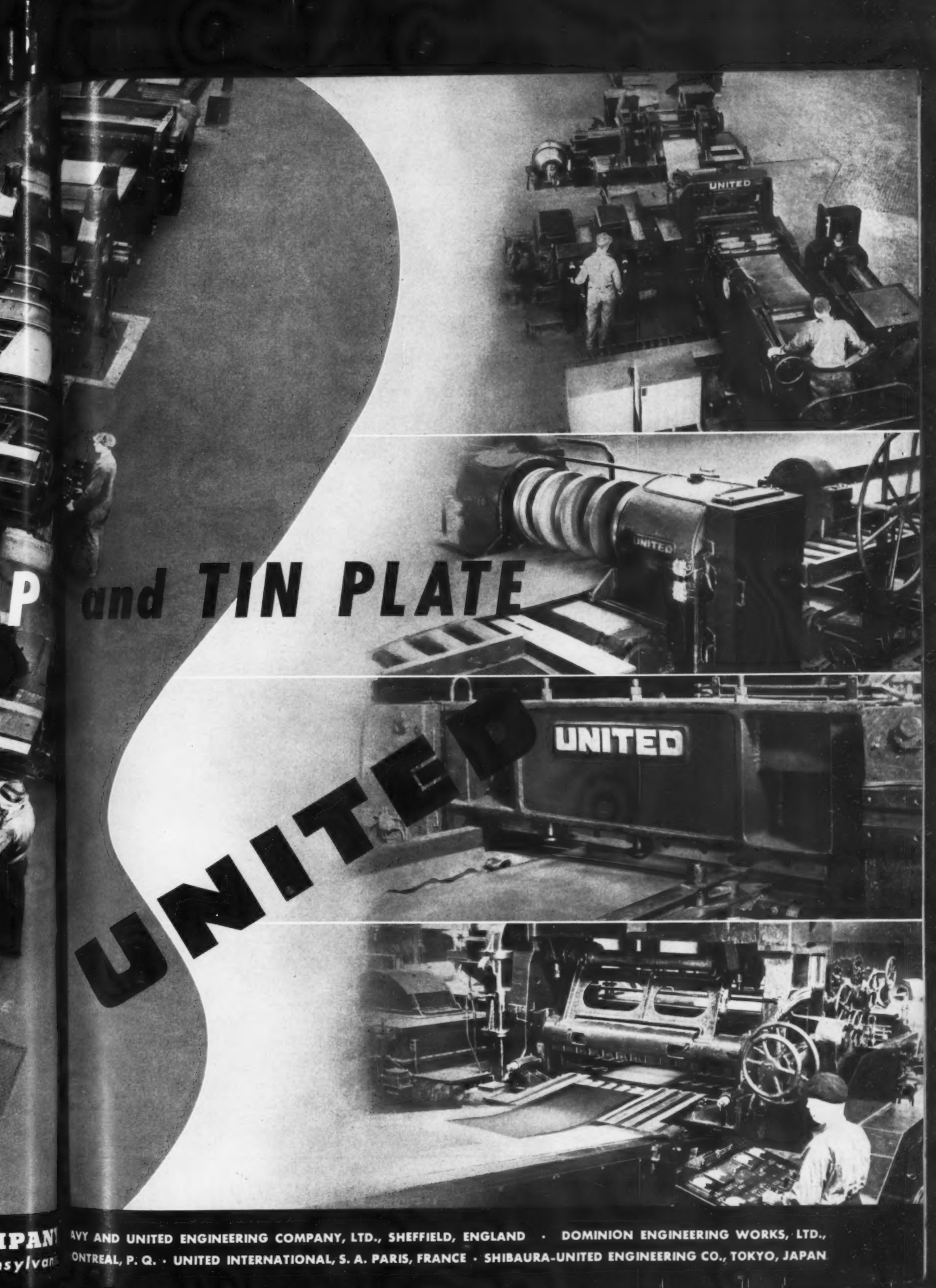
Solenoid operated, single pole, 3000 ampere, 250-volt d-c Type RM circuit breaker, arranged for load-measuring automatic reclosing control.

I-T-E CIRCUIT BREAKER CO., PHILADELPHIA, PA.

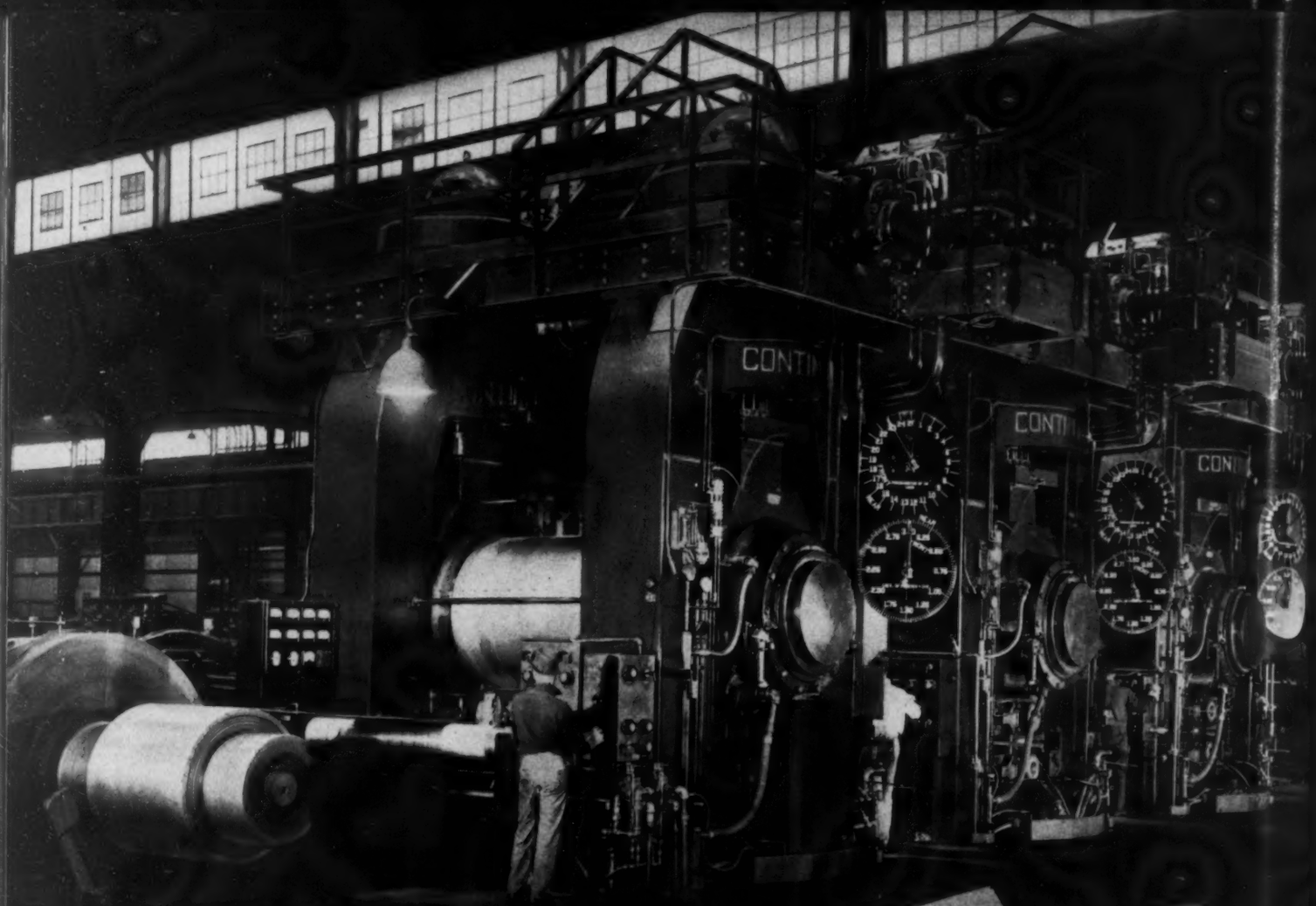


UNITED ENGINEERING *and* FOUNDRY COMPANY

Pittsburgh · Pennsylvania

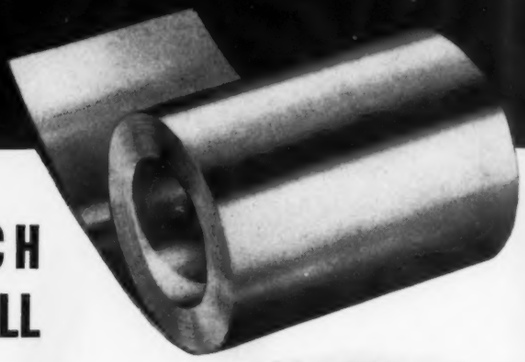


AVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND · DOMINION ENGINEERING WORKS, LTD.,
ONTREAL, P. Q. · UNITED INTERNATIONAL, S. A. PARIS, FRANCE · SHIBAURA-UNITED ENGINEERING CO., TOKYO, JAPAN



DESIGNED AND BUILT BY CONTINENTAL
FOR THE
CARNEGIE ILLINOIS STEEL CORPORATION

CONTINENTAL 84-INCH
3-STAND TANDEM COLD REDUCTION MILL



THE 20½ in. and 56 in. by 84 in. three-stand tandem cold reduction mill illustrated above was designed and built by Continental for the Carnegie-Illinois Steel Corporation. Designed for roll pressure of 11,000,000 pounds. Rolls cold strip 80 in. wide from .125 in. thickness to .030 in. in one pass through the three stands. Housing screws, 28 in. in diameter. Housing post sections, 1000 square inches. Total horsepower, 8500.

4 PLANTS
SERVING THE STEEL INDUSTRY

© CONTINENTAL—HUBBARD DIV., EAST CHICAGO, IND.

© CONTINENTAL—DUQUESNE DIV., CORAOPOLIS, PA.

© CONTINENTAL Wheeling Division | Peninsula Plant Warwood Plant Wheeling, W.Va.

CONTINENTAL ROLL & STEEL FOUNDRY COMPANY

Manufacturers of Rolling Mill Equipment, including Steel and Alloy Steel Castings, Iron and Alloy Iron Rolls, Steel and Alloy Steel Rolls

CHICAGO, ILL. and PITTSBURGH, PA.

Continental Direct Fired Annealing Furnaces
Continental Universal Industrial Gas Burners
Pittsburgh-Continental Annealing Covers

EC&M Announces—

DYNAMIC LOWERING CONTROL for A-C CRANE HOISTS

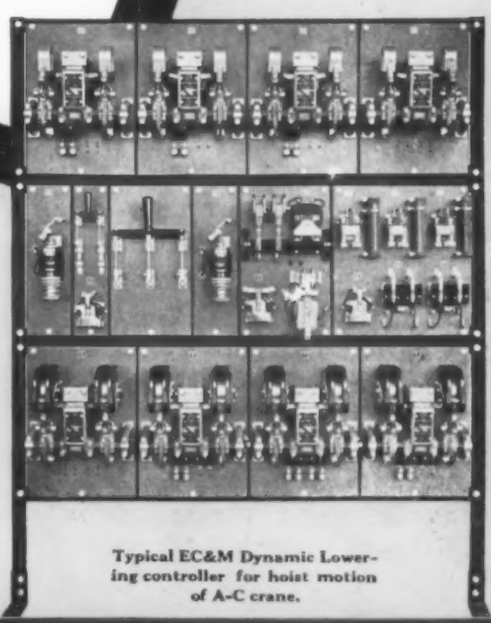
This Test-Hoist, complete with motor, controller, etc., will be in operation at Pittsburgh. Various loads will be available to demonstrate actual working conditions found in foundry, freight-handling, warehouse, dock, magnet and similar crane-service.

Operate your A-C Cranes now

1. By dynamic braking
2. Without mechanical load-brake
3. By standard sequence of operation of Master Switch

and obtain

1. Precision inching
2. Elimination of load-brake maintenance
3. Simple master switch control—both lowering and hoisting motions start on first point of master
4. Increased crane output by lowering heavy loads at 150% (hyper-synchronous) speed



Typical EC&M Dynamic Lowering controller for hoist motion of A-C crane.

At last—perfected crane control for A-C motor driven hoists, developed by EC&M, the originators of dynamic braking control for D-C cranes in 1912. Now—it is also possible to operate A-C cranes by dynamic braking, permitting low cost and precise operation. With this control, there is no mechanical load brake to wear and require attention; instead, the load is raised and lowered directly by the motor and control using A-C power only.

In inching operations, the short movements of the crane hook possible with this control will surprise you. And when lowering heavy over-hauling loads, the use of hyper-synchronous speeds (as much as 50% faster than previously obtained) will materially increase the output of a crane.

Make it a point to examine this revolutionary control at the Iron and Steel Exposition. Use the opportunity of this initial showing to witness and personally operate this new control of far-reaching importance to crane users.

ELECTRIC CONTROLLER & MFG. CO. E&M CLEVELAND, OHIO

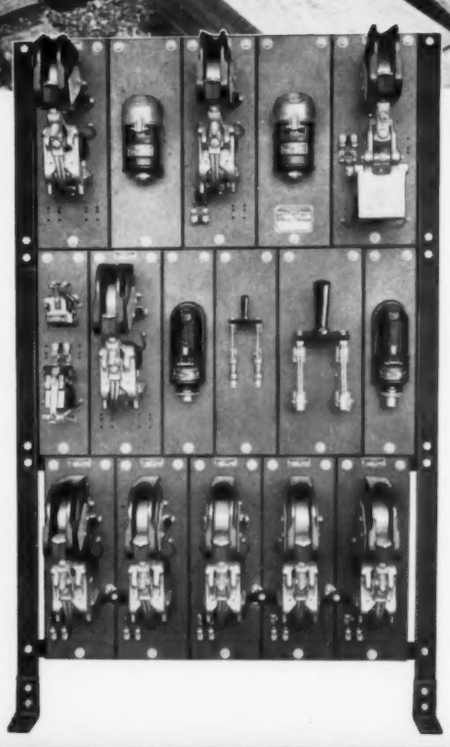
HEAVY DUTY MOTOR CONTROL FOR CRANES, MILL DRIVES AND MACHINERY • BRAKES • LIMIT STOPS • LIFTING MAGNETS AND AUTOMATIC WELD TIMERS.

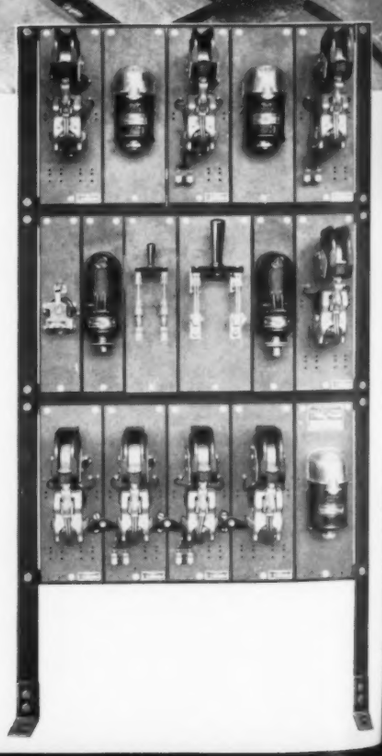
Examine and operate this Outstanding Control at Booths 200 to 203
IRON & STEEL EXPOSITION — PITTSBURGH, SEPT. 26 to 29

AT IRVIN WORKS—EC&M

Hoist Motor Commutators ★ tell the story!!!

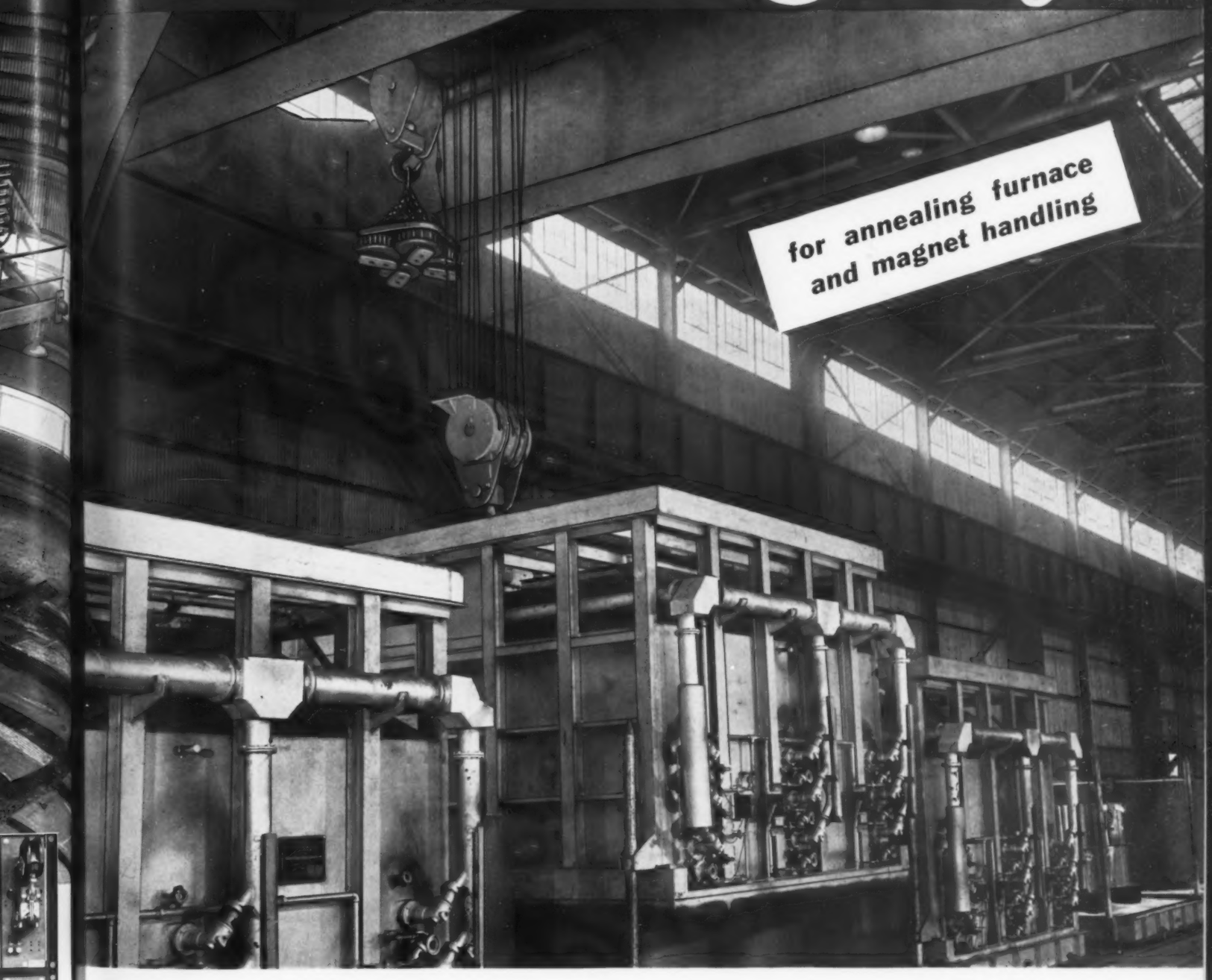
Good crane-hoist control requires responsive regulation when lowering a load. With the EC&M Wright Circuit Controller, **the operator can stop the load by quickly returning the master to the off position from any speed point without exceeding the capacity of the motor,*** because this controller is properly proportioned. As a proof of this statement, the hundreds of crane-hoist motors successfully operated by Wright Circuit Controllers show perfect commutation. Check this fact!





WHEN BUYING CRANES

CRANE CONTROL *Stands Out*



THERE'S a smoothness, a lack of effort, a quickness of response that makes EC&M Crane Control stand out in the industrial material handling field. Plant operating men know from experience that EC&M control turns out the greatest production at lowest cost and crane operators know that they can "spot a load" or "move tonnage" with speed and with safety by means of this top-ranking control.

The reason for this is that there is no other magnetic crane control having the outstanding advantages of (1) The WRIGHT DYNAMIC LOWERING CIRCUIT for Hoist Motions (2) TIME-CURRENT ACCELERATION and (3) LINE-ARC Magnetic Contactors. The Wright Circuit, for example, is not only safe (there is no danger of over-speeding when handling capacity loads) but this controller also permits a wide range of speed control—from precision inching to high speed lowering. Ask any crane operator to show you the advantages of Time Current Acceleration—how this system of control provides velvet smooth operation—as fast as the motor is able to accelerate the load. In addition, make it a point to see how LINE-ARC Magnetic Contactors handle the arc—an assurance of low up-keep cost. Note that destructive burning of arc-shields has been entirely eliminated and that contacts stand up because the arc is instantly removed from them as soon as the contactor starts to open.

Our nearby sales office would be glad to arrange for a demonstration of these facts. Consult him today for proof, based on performance. **Electric Controller & Manufacturing Co., Cleveland, Ohio.**

ELECTRIC CONTROLLER & MFG. CO. E&M CLEVELAND, OHIO, U.S.A.

HEAVY DUTY MOTOR CONTROL FOR CRANES, MILL DRIVES AND MACHINERY • BRAKES • LIMIT STOPS • LIFTING MAGNETS AND AUTOMATIC WELD TIMERS.

ES SPECIFY EC&M CONTROL

LIFTS SINGLE COIL ONLY

Doesn't disturb coil-spacer—
Doesn't lift annealing base—
No foreign material clings to bottom of coil which would injure coil when redeposited

EC&M No. 4 CSM Magnet removing coil from annealing base— Note that coil spacer remains on top of bottom coil

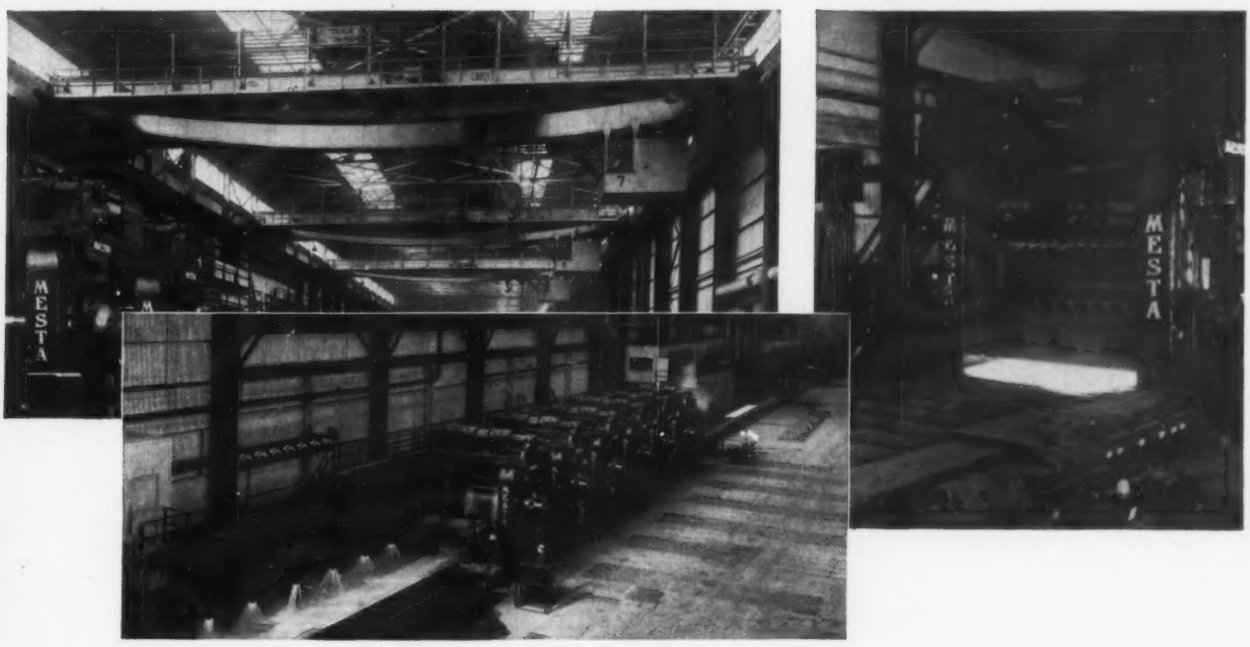
FROM the new and modern Irvin Works of Carnegie-Illinois Steel Corporation comes an outstanding discovery in regard to the operation of EC&M type CSM Coil-handling Magnets. They have found that only one coil is lifted and nothing clings to the bottom of the coil as a coil is conveyed by one of their EC&M type CSM magnets. When lifting coils from an annealing furnace, only the coil is lifted, the coil-spacer used between coils remaining in position on top of the under coil, as illustrated. When removing the last coil from an annealing-base, the base is not carried with the coil and dropped on the floor and broken—the breaking of cast annealing bases, previously an expensive item of maintenance, has been entirely eliminated since using type CSM magnets. Also since nothing clings to the under side of the coil there is no danger of foreign material such as chips, scale, etc., injuring the bottom coil edges when coil is redeposited.

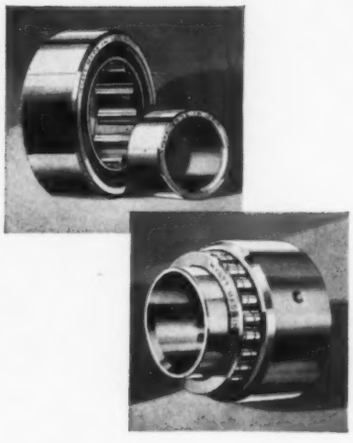
Designed especially for finished coil handling, EC&M type CSM magnets have many other important advantages. Being about coil size they permit ready access to any coil in closely stacked, stock piles. The load is balanced. Crane operators have a good view of the work because these magnets are compact. Men in charge at Irvin Works tell us that crane operators like these type CSM magnets so well that "they can't get them off the hook." Get the facts on type CSM Coil-handling Magnets from our nearby sales office today. **The Electric Controller & Mfg. Co., Cleveland, Ohio.**

THE ELECTRIC CONTROLLER & MFG. CO. E&M CLEVELAND, OHIO

There's greater safety and less cost when you use a CSM MAGNET for COIL HANDLING

SERVING AND SAVING
YEAR AFTER YEAR





● At the Iron and Steel Exposition you are invited to visit with us — Space 74 — Lower Exposition Hall.

On A. I. & S. E. Inspection Trips, year after year, you witness the widespread application of Hyatt Roller Bearings. Now, in this great 80" Continuous Hot Strip Mill . . . the Irvin Works of the Carnegie-Illinois Steel Corp. . . . you again will see Hyatts serving and saving.

Tables, cranes, motors, and trucks operating on Hyatt Roller Bearings . . . giving similar satisfactory performance here as are the thousands and thousands of Hyatts serving other modern mills throughout the country. Hyatt Bearings Division, General Motors Sales Corporation, Harrison, N. J., Chicago, Pittsburgh, Detroit, San Francisco.

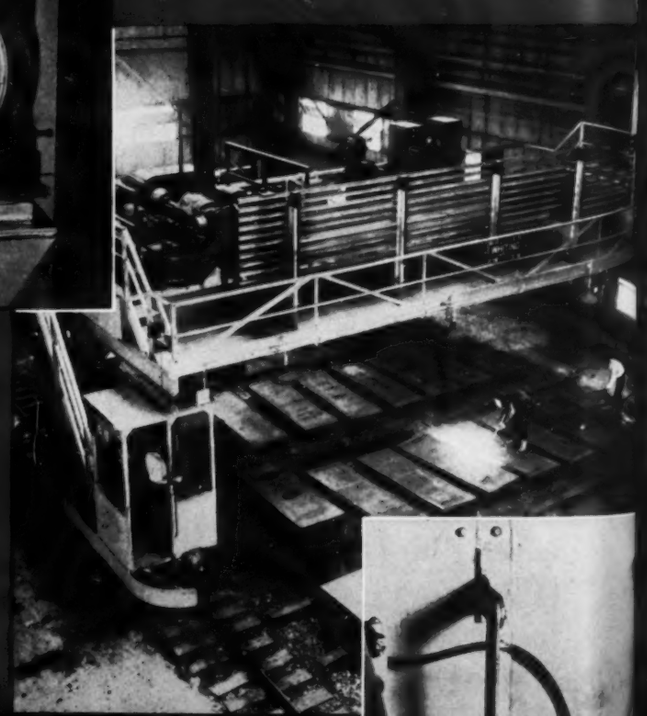
HYATT *Roller* BEARINGS

WAGNER HYDRAULIC BRIDGE BRAKES

At the IRVIN WORKS

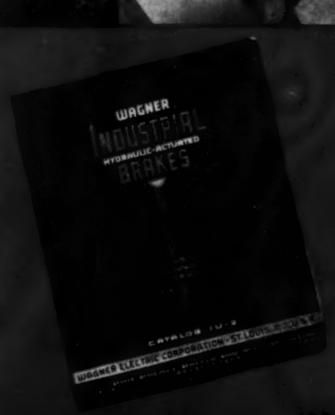
Wagner Hydraulic Bridge Brakes have many outstanding advantages, a few of which are enumerated below:—

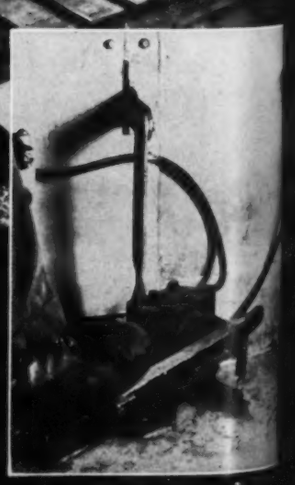
1. Provide smooth powerful braking.
2. Permit more accurate placing of loads.
3. Insure quick, safe stops when power fails.
4. Equal torque at each brake on double bridge drives.
5. Eliminate maintenance of linkage and shafting.
6. Permit prohibition of motor plugging.
7. Save space because linkage is not required.
8. Reduce maintenance cost.



This Catalog on HYDRAULIC BRAKES

for overhead traveling cranes and other industrial applications, should be in the hands of all present users of hydraulic brakes. It contains complete service instructions and parts information. It is also of interest to all plant engineers who have not yet taken advantage of the safety and economy features offered by hydraulic foot brakes for overhead traveling cranes. Write for your copy today. No obligation.





Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

BRAKES • TRANSFORMERS • FANS • MOTORS

WAGNER INDUSTRIAL BRAKE LINING

for ALL types of... INDUSTRIAL BRAKES

Brake wheel scoring has presented a problem for many years, which Wagner solved by offering a molded block of non-abrasive material, with a wire backing for strength and suitable for use with all types of brake wheels.

Advantages of WAGNER INDUSTRIAL BRAKE LINING

1. Will not score brake wheels.
2. Wire-backed to permit deep seating of rivets.
3. Suitable for use on all types of brake wheels.
4. Formed to correct size and wheel diameter.
5. All blocks are part numbered to insure the proper application.
6. Saves installation time and reduces inventory.

WILL NOT SCORE BRAKE WHEELS

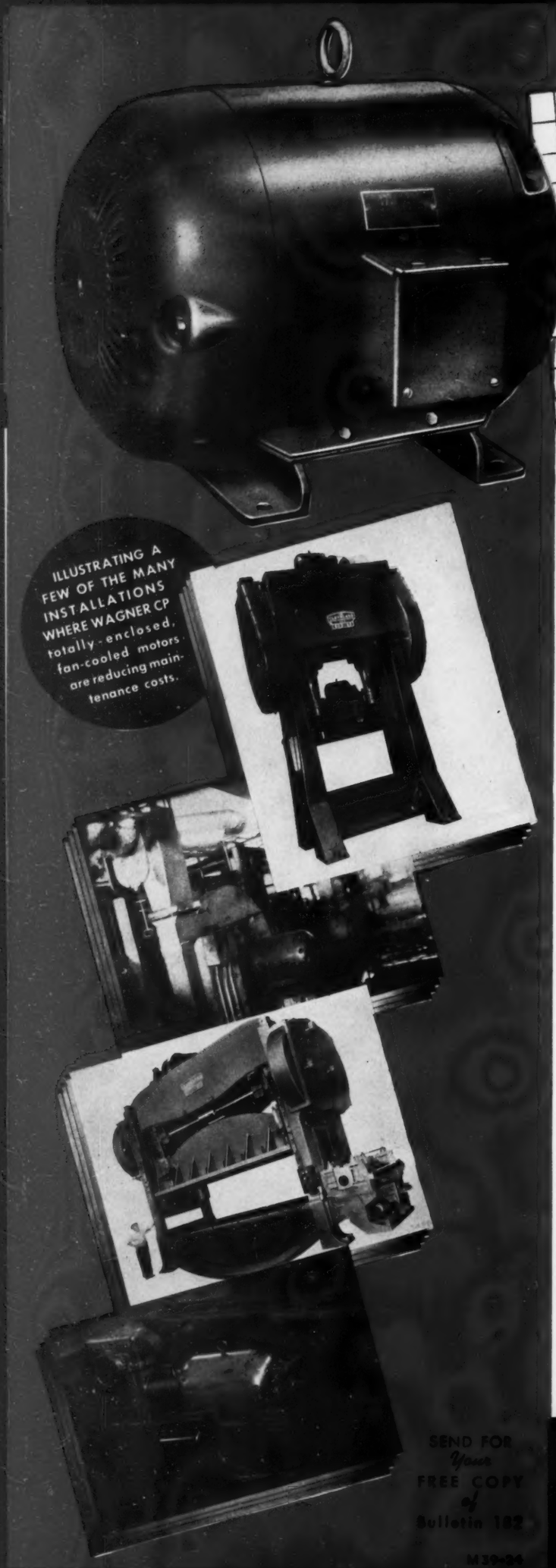
Wire back permits deep seating of rivets thus increasing thickness available for service.

GET COMPLETE *Information* TODAY

Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

BRAKES • TRANSFORMERS • FANS • MOTORS


ILLUSTRATING A FEW OF THE MANY INSTALLATIONS WHERE WAGNER CP totally-enclosed, fan-cooled motors are reducing maintenance costs.
SEND FOR Your FREE COPY of Bulletin 182
M39-24

MAINTENANCE COSTS Go Down When WAGNER MOTORS Are Put on the Job-

The high efficiency and dependability of Wagner, totally enclosed fan-cooled motors make them the choice in the iron and steel industries.

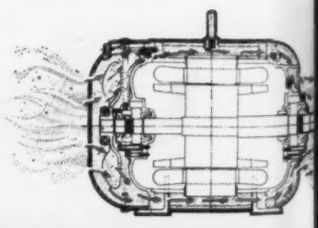
Thousands of them now in service attest to their ability to reduce maintenance costs by giving longer service under the most severe conditions.

Here are some of the reasons why they give longer service:

1. Rugged, welded all-steel stator with specially impregnated windings.
2. Dynamically-balanced rotor, equipped with sturdy shaft having all key-ways end milled.
3. Full-cartridge-bearing construction which completely seals and protects the ball bearings.
4. Easily accessible grease plugs permitting lubrication without removing fan shield or stopping motor.
5. End plates heavily and ruggedly constructed, with air deflector on shaft end.
6. Single-end ventilation with non-clogging, one-piece aluminum fan of split hub construction.
7. Fan shield formed from sheet steel and easily removable for access to fan.
8. Nine leads connectable for either 220 or 440 volts completely sealed in outlet, making it impossible for abrasive materials to enter motor.

The Two-Frame Construction Keeps Dust, Dirt and Metal Chips from Entering the Vital Parts of the Motor—

Examine the cross-section drawing of the Wagner CP totally-enclosed fan-cooled motor illustrated at right. There are two frames—an outer frame that guides a strong cooling draft over the motor, and an inner frame with clearances around the shaft only, through which nothing obstructive or injurious can enter the vital parts of the motor.



Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

MOTORS • BRAKES • TRANSFORMERS • FA

HERE AGAIN-

POSITIVE PROTECTION AGAINST COSTLY FUEL LOSSES WITH J-M INSULATIONS

TO PROVIDE a lasting, efficient safeguard against excessive heat waste, operators of the Irvin and Edgar Thomson Works depend on Johns-Manville Insulations. Many different J-M Materials are used to meet a wide range of operating conditions. All are products of more than 80 years' experience and research . . . each has established a proved record of dependability in hundreds of plants all over the United States. One or more of the complete line of Johns-Manville Insulations will help you maintain positive control of temperatures at minimum fuel cost. For full details write for Insulation Brochure IN-55A. Johns-Manville, 22 East 40th Street, New York, N. Y.

AMSLER-MORTON Soaking Pits, including recuperators and preheated air flues, at Edgar Thomson Works are insulated with J-M Superex Blocks. Even under severe operating conditions, Superex gives long, low-maintenance service.

ON THIS Surface Combustion Continuous-Sheet Normalizing Furnace at Irvin Works, J-M Insulations provide an efficient heat-barrier. Used here are J-M Sil-O-Cel Natural Brick, JM-20 Brick; J-M No. 450 and 500 Cements.

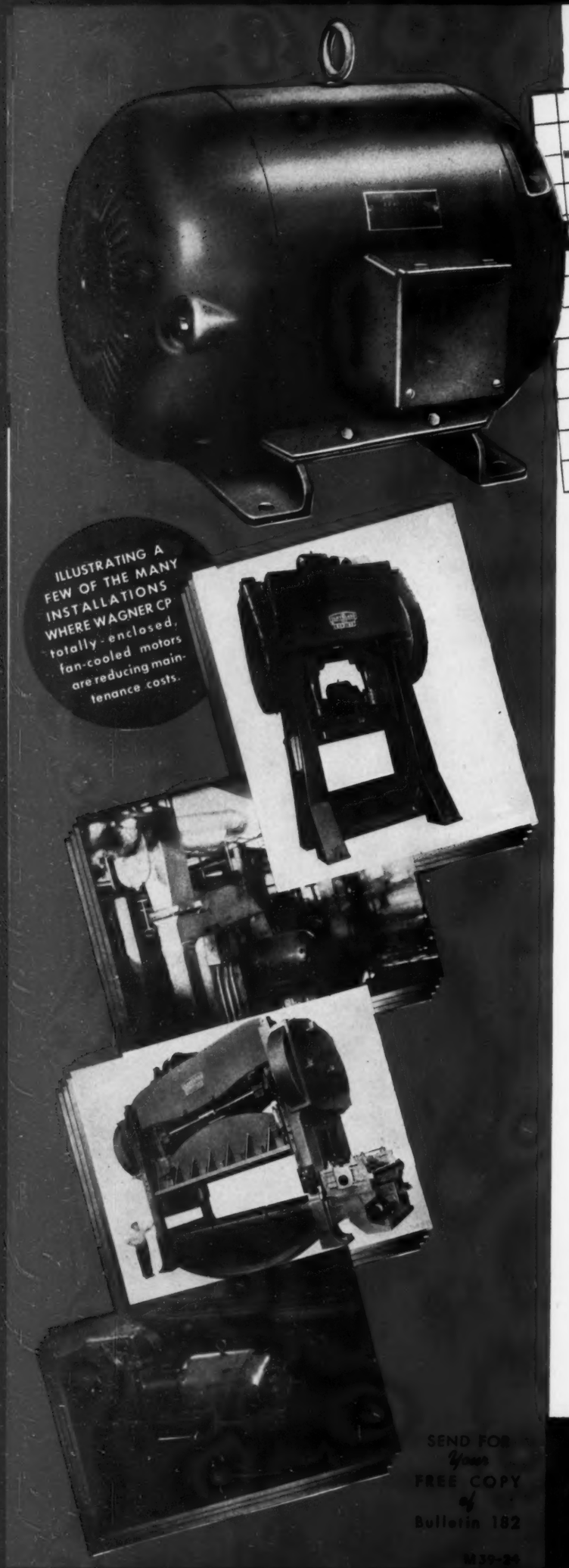
ON THESE Rust Triple-Fired Continuous Slab Heating Furnaces, dependable control of temperatures is assured at all times through the use of J-M Superex Blocks, J-M Sil-O-Cel C-22 and Super Brick, and J-M No. 500 Cement.

SIXTEEN Swindell-Dressler Tube-Type Annealing Furnaces at Irvin Works. Effectively insulated with J-M Superex Blocks, JM-20 Brick and J-M No. 500 Cement.

WALLS, ROOFS AND BASES of 16 Lee Wilson Tube-Type Annealing Furnaces at Irvin Works are protected against costly fuel waste with J-M Superex Blocks.

For every temperature...
For every service condition

Johns-Manville **INDUSTRIAL INSULATIONS**



ILLUSTRATING A FEW OF THE MANY INSTALLATIONS WHERE WAGNER CP totally-enclosed, fan-cooled motors are reducing maintenance costs.

SEND FOR Your FREE COPY of Bulletin 182

M39-25

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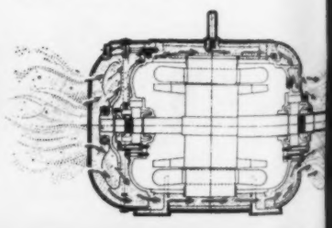

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MOTORS • BRAKES • TRANSFORMERS • FANS

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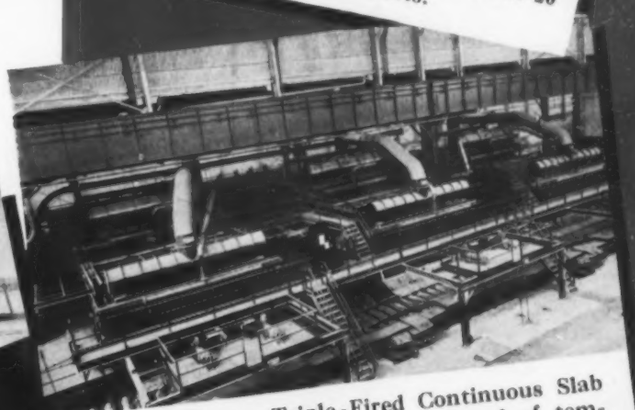

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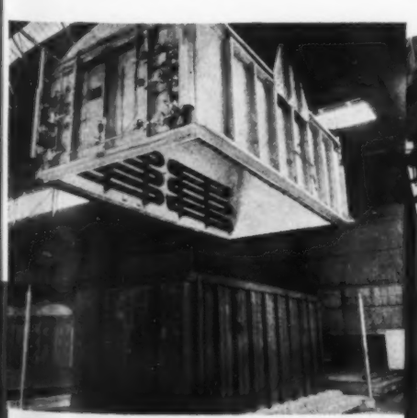

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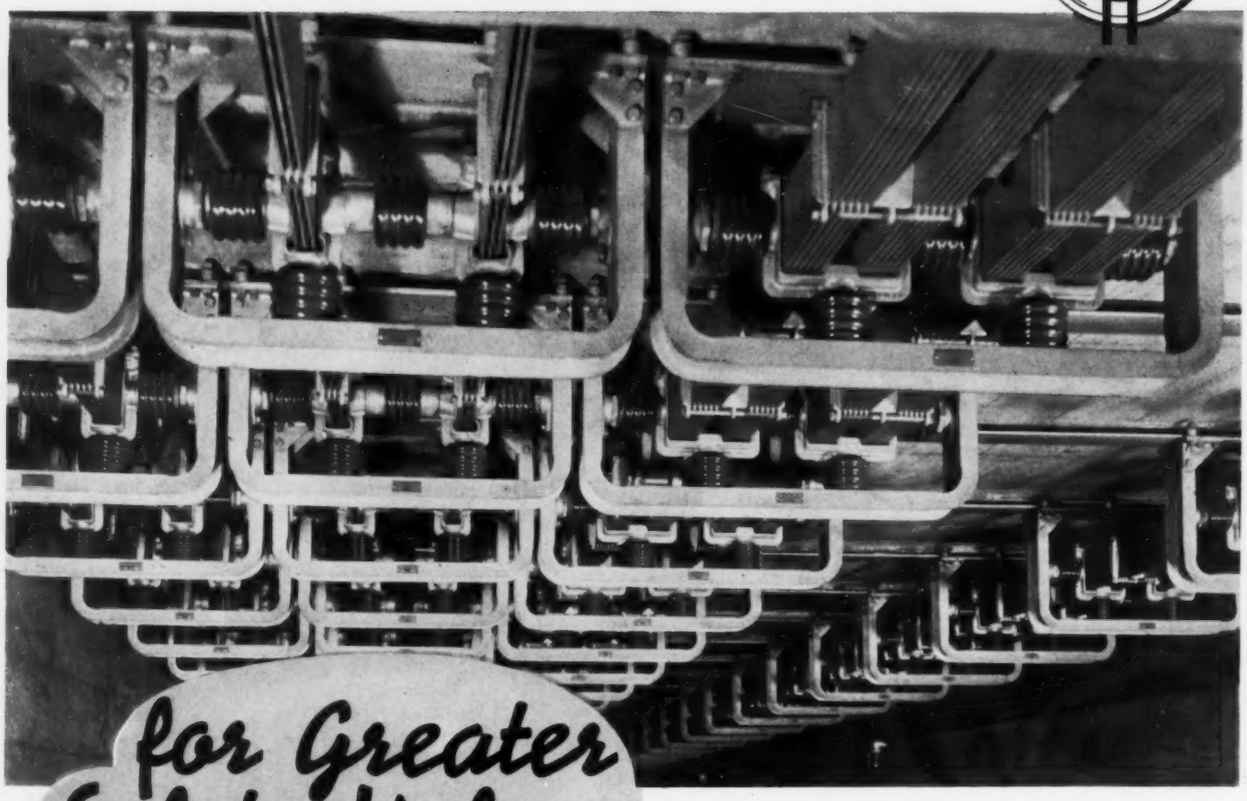
MORE FT-LBS PER $



for Greater Safety Value install—

DELTA-STAR

REINFORCED BUS SUPPORTS

Steel mills all over the country are using reinforced bus structures more and more—there must be a reason.

Simply this—GREATER SAFETY VALUE, or in the language of the engineer—MORE FOOT-POUNDS PER DOLLAR. You actually pay less and get more. And when you buy SAFETY you get greater freedom from disastrous effects of short-circuits . . . . . more assurance of service continuity . . . . . peace of mind.

The above installation at Irvin Works of Carnegie-Illinois Steel Corporation is one of the latest—a splendid example of the fine results obtained by the co-ordinated efforts of purchaser's engineers and the DELTA-STAR staff.

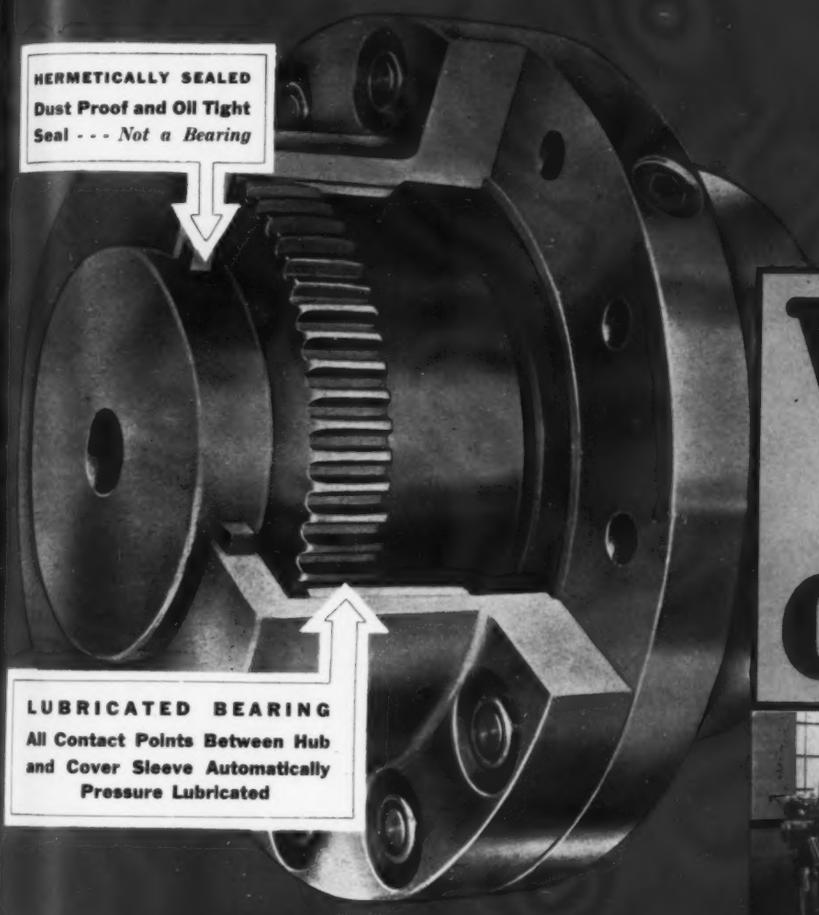
One look at any DELTA-STAR REINFORCED BUS INSTALLATION and you will be impressed by the BUSINESS-LIKE appearance . . . . the sense of SECURITY proclaimed.

DELTA-STAR ELECTRIC CO.

2400 Block, Fulton St. Chicago, Illinois

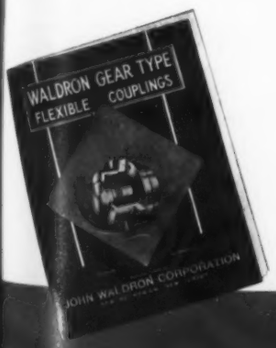
Built for the Future *Based on the Past*

Your Best Assurance of *Trouble-Free* Operation!


HERMETICALLY SEALED
Dust Proof and Oil Tight
Seal - - - *Not a Bearing*
LUBRICATED BEARING
All Contact Points Between Hub and Cover Sleeve Automatically Pressure Lubricated

WALDRON *Gear* COUPLING

Write for
New Bulletin
No. S - 55



The swing is to Waldron, the Coupling of surpassing performance. Day by day it is being established as the outstanding Coupling on the market. A Coupling of superior workmanship and material incorporating many major refinements in design. Get the facts — and you will specify a Waldron Coupling on your next job.

JOHN WALDRON CORPORATION

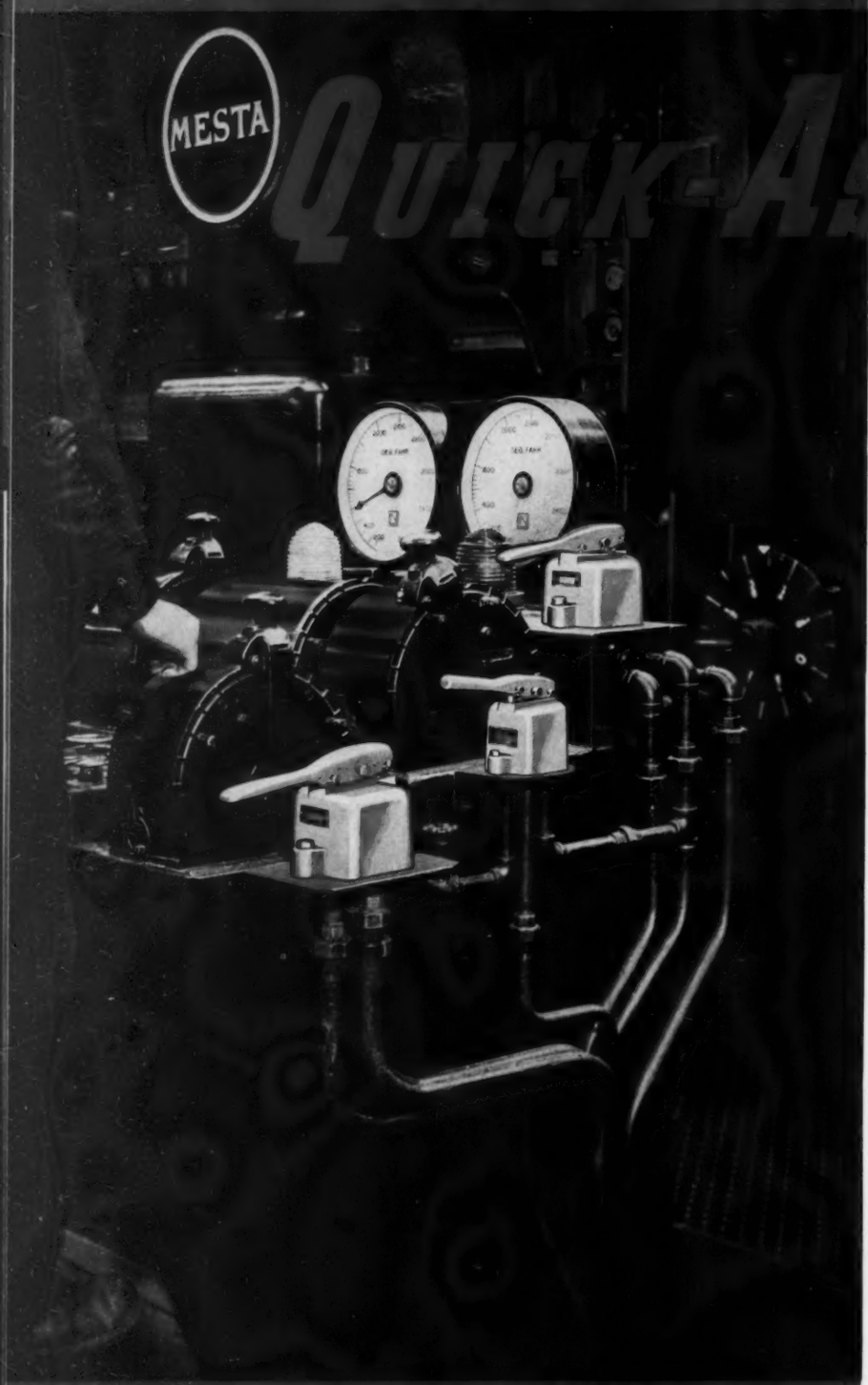
NEW BRUNSWICK, NEW JERSEY

MESTA

QUICK-AS-WINK

CONTROL VALVES

FOR AIR—WATER—OIL



● Constantly gaining in favor in the leading iron and steel plants because they insure longer, more reliable service. All employ the Quick-As-Wink valve principle, no metal-to-metal contact, always in balance in any position; the higher the pressure the tighter the seal. Streamlined to present finer appearance; made of highest quality materials.

C. B. HUNT & SON

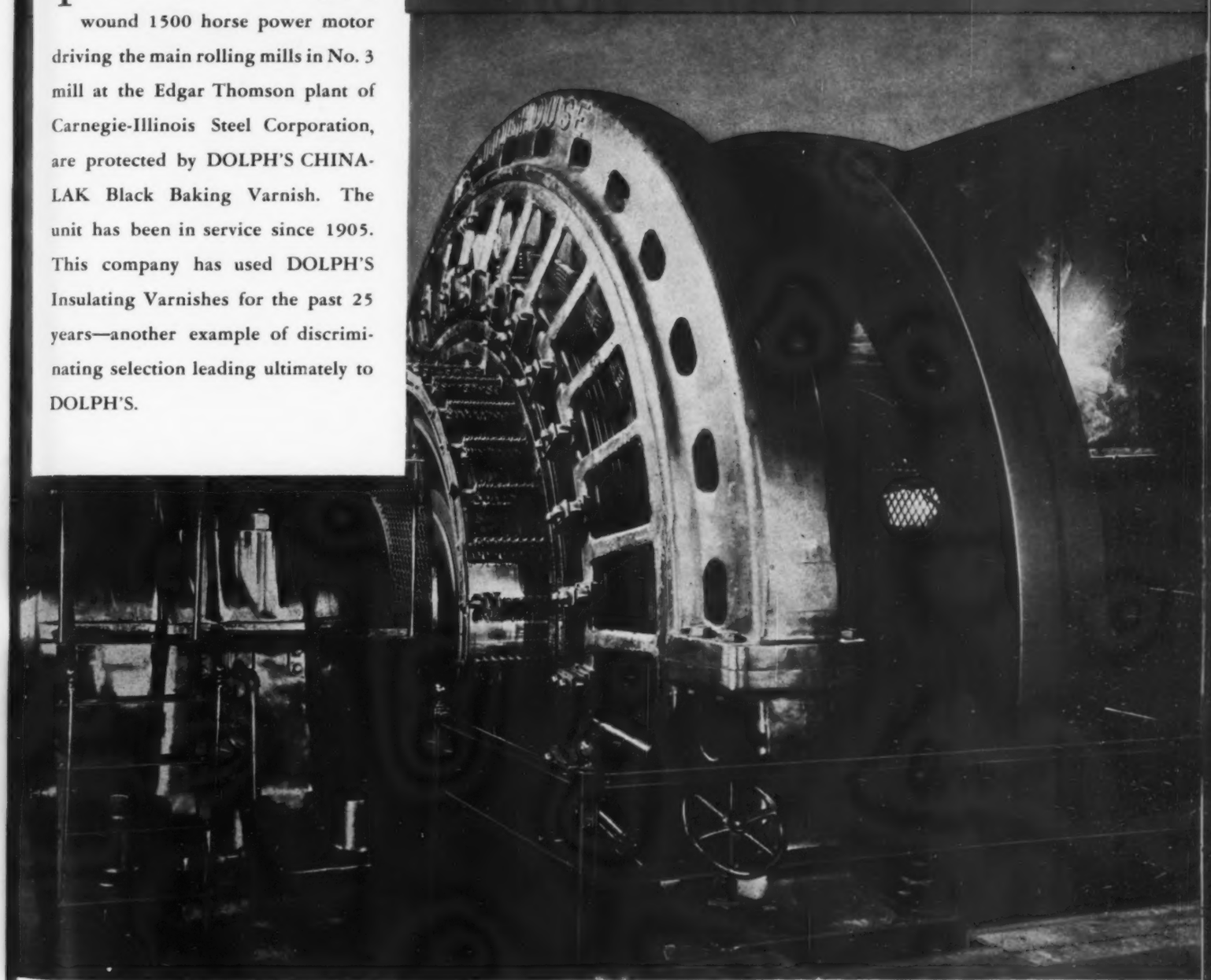
Salem, Ohio

Dolph's

CHINALAK

PROTECTS THE MAIN DRIVE AT EDGAR THOMSON

THE windings of this compound wound 1500 horse power motor driving the main rolling mills in No. 3 mill at the Edgar Thomson plant of Carnegie-Illinois Steel Corporation, are protected by DOLPH'S CHINA-LAK Black Baking Varnish. The unit has been in service since 1905. This company has used DOLPH'S Insulating Varnishes for the past 25 years—another example of discriminating selection leading ultimately to DOLPH'S.



JOHN C. DOLPH CO.

INSULATION SPECIALISTS

166 EMMETT STREET NEWARK, N. J.

REPRESENTED IN PITTSBURGH, PA. BY EARL B. BEACH CO., HARDY & HAYES BLDG., 233 OLIVER AVENUE

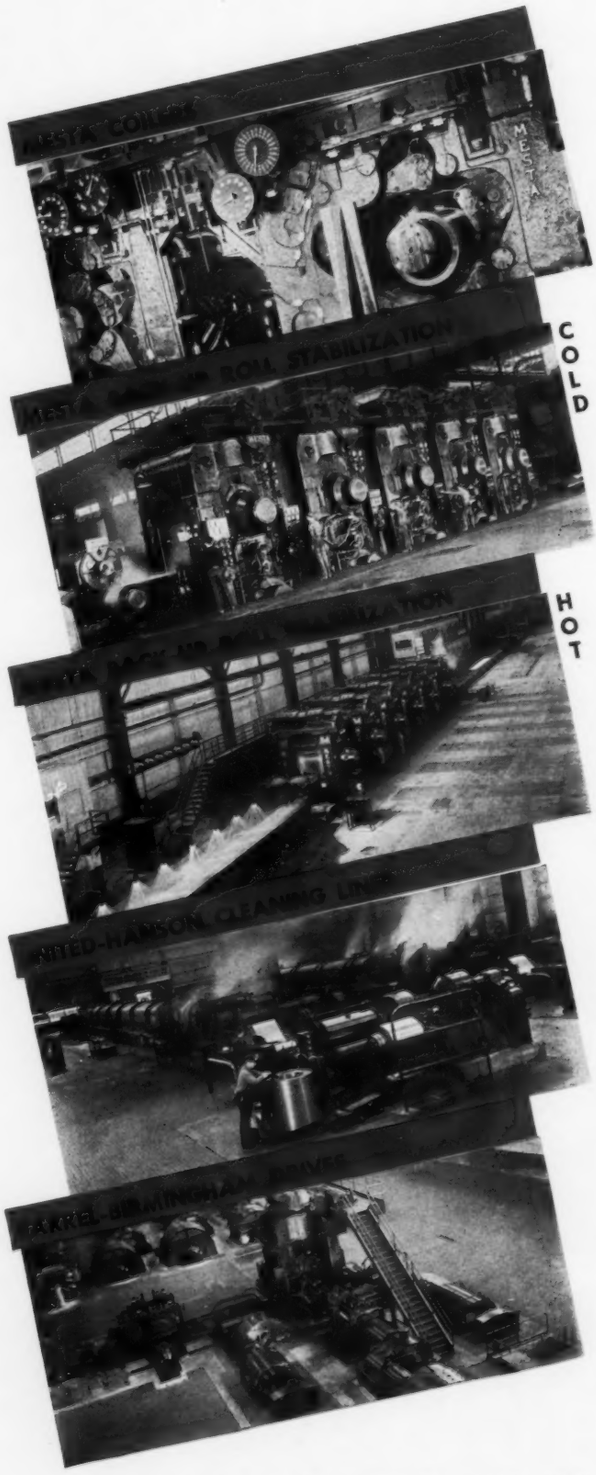
SKF SPHERICAL BEARINGS ARE

in the Irvin Works

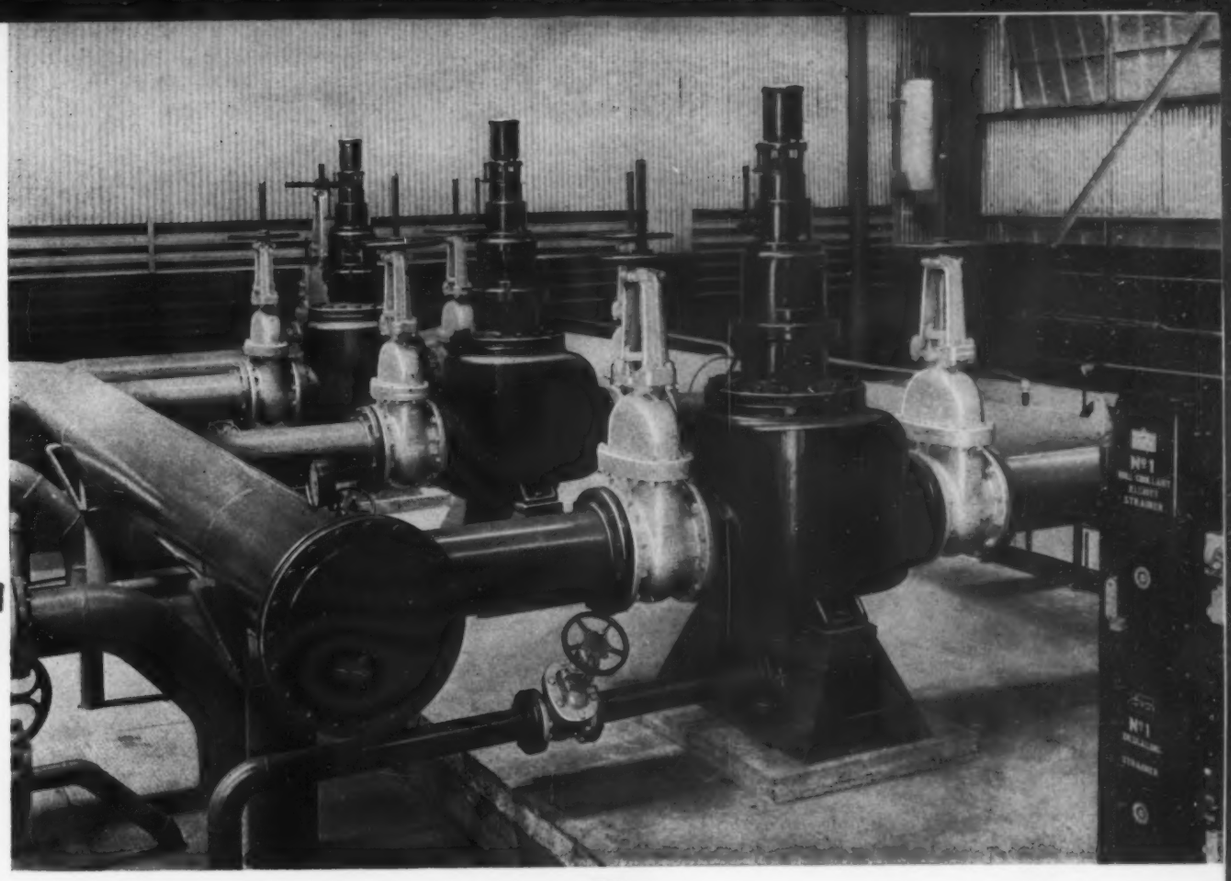
The increasingly widespread use of **SKF** Spherical Roller Bearings in the steel industry is concrete evidence of their ability to give good performance under severe conditions.

Steel mill men have *profited* from the carefree operation and long life obtained from mills incorporating the high capacity and inherent rolling alignment of **SKF** Bearings.

Submit *your* proposals to your nearest **SKF** representative, or write direct to our engineering department. **SKF** Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa. 4408



SKF *Bearings*



Here is CONTINUOUS STRAINING

for continuous hot strip mill roll-cooling system

ELLIOTT Self-Cleaning STRAINERS

This line of three Elliott 14" Type K self-cleaning strainers continuously strains the water used for the roll-cooling system on the new 80" continuous hot strip mill in the Irvin Works of Carnegie-Illinois Steel Corporation. There is also a 6" Type K strainer handling water for one of the descaling systems.

This type of strainer is excellent for continuously removing fine dirt from water. Inside the strainer body, a series of straining sections made of alternate layers of flat and corrugated copper strips securely fastened together are inserted in channels in a circular cage. A geared motor slowly rotates sealing boxes, which blank off straining sections in turn, permitting back pressure to flush these sections and carry foreign matter down through the drain at the bottom of the strainer. Bearings are immune to cutting or scoring by dirt or grit. An entirely satisfactory self-cleaning strainer, built for continuous service and requiring no attention.

Write for descriptive Bulletin A-8.

●

Also installed in the Irvin Works, are six Elliott 600-hp. squirrel cage, 6600-volt, across-the-line starting motors driving pumps in the main pumping station at the river. These pumps handle 24,000,000 gal. per day.

ELLIOTT COMPANY

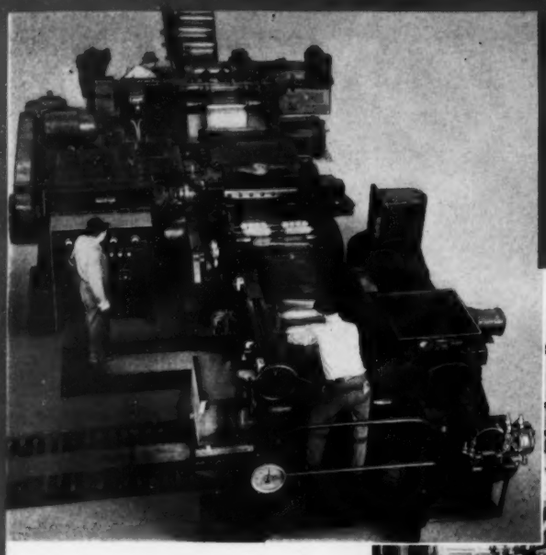
Accessories Dept., JEANNETTE, PA.

District Offices in Principal Cities

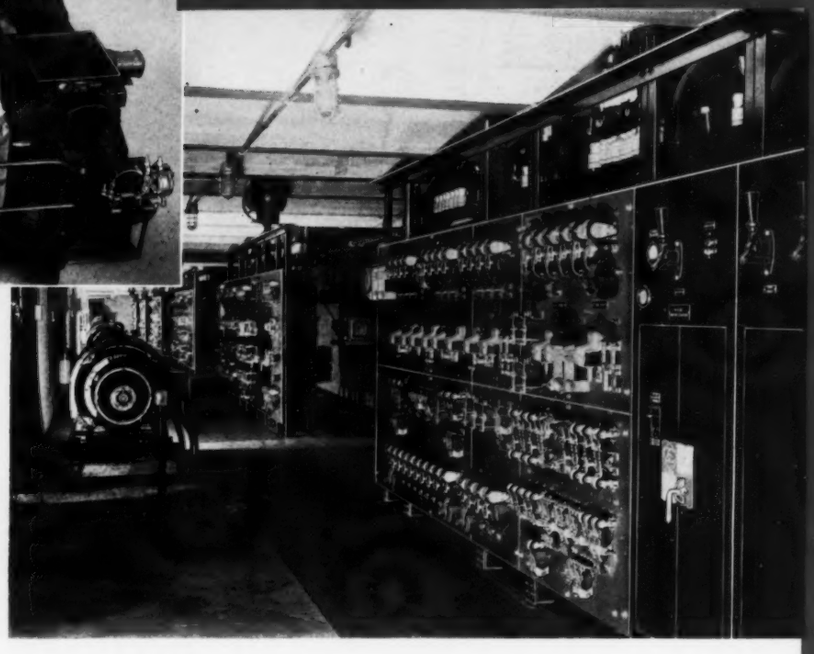
ELLIOTT BUILDS DEPENDABLE POWER EQUIPMENT:

TURBINE-GENERATORS • ENGINE-GENERATORS • MOTOR-GENERATORS • GENERATORS • ENGINES • MOTORS • MECHANICAL DRIVE TURBINES • CONDENSERS • DEAERATORS • DEAERATING HEATERS • FEEDWATER HEATERS • STEAM JET EJECTORS • VACUUM COOLING EQUIPMENT • CENTRIFUGAL BLOWERS • DESUPERHEATERS STRAINERS • SEPARATORS • GREASE EXTRACTORS • FILTERS NON-RETURN VALVES • LAGONDA & LIBERTY TUBE CLEANERS

A-245



BACK OF ACCURATE LOW COST HIGH SPEED PRODUCTION ARE "3C" CONTROLS



¶ This tin plate shear line runs at the rate of 400 feet per minute, cutting 34½" lengths to commercial accuracy. This means 139 cuts per minute, or 8340 commercially accurate cuts per hour.

¶ Eight motors, with a total of 167 H. P., plus a 50 KW M. G. set operate this shearing line, yet with rapid operation and sudden braking, only a negligible amount of electrical control maintenance is required.

¶ Shown in the Shearing Line picture are "3C" Brakes, Mill Master Switch, and Master Bench Board, all contributing to accurate production and low maintenance.

¶ Trustworthy, experienced engineering practice, high grade materials precision made, and correctly assembled and wired by trained workmen under careful supervision, are the background for "3C" control accuracy, long life and low maintenance.

¶ The benefits of "3C" Steel Mill Electrical Control background are at your service.

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

Schloemann Installations in a plate mill at Pittsburgh

Left—"Motor-Roller" equipped Scale Table

Below—
"Motor-Roller" equipped Shear Depressing Table

EXCLUSIVE ADVANTAGES *of* SCHLOEMANN "MOTOR-ROLLERS"

With the rotating trunnion-type roller housing the driving motor, the necessity for using line shafts, couplings and gear reduction units is eliminated. Simplified table construction is the result, affording free access along both sides of "Motor-Roller" Tables.

Installation of rollers between the housings of Mill Stands and Shear Housings is possible without introducing complicated or weak elements.

Fewer wearing parts provide the ruggedness and dependability essential in mill service with r duced operating and maintenance costs.

Each "Motor-Roller" installation is designed and bu for the particular requirements of its application.

SCHLOEMANN

ENGINEERING CORP.
Rolling Mill Machinery

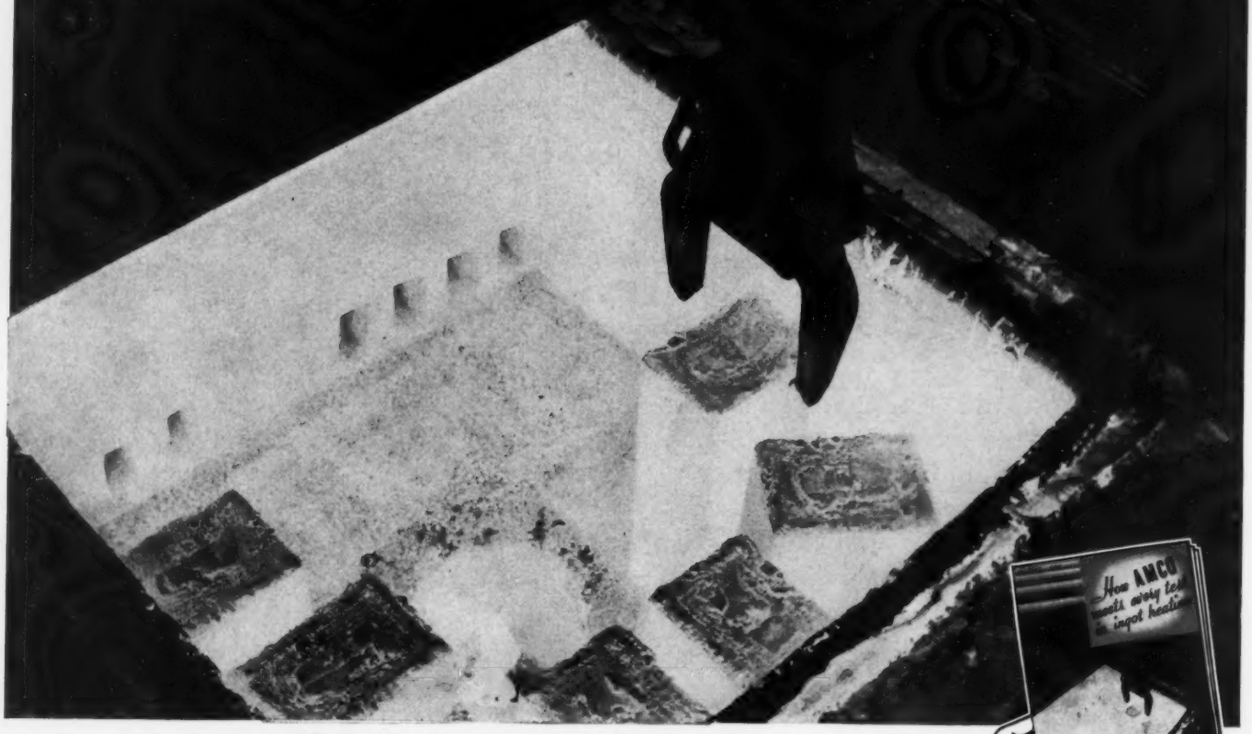
PITTSBURGH, PA.
Hydraulic Presses

Produces a hot plastic condition without washing

A User of AMCO PIT FURNACES *says:*

"I would say the day is past when any kind of steel should be washed. With the modern AMCO PIT FURNACES it is possible to produce a very hot plastic condition *without any washing.*"

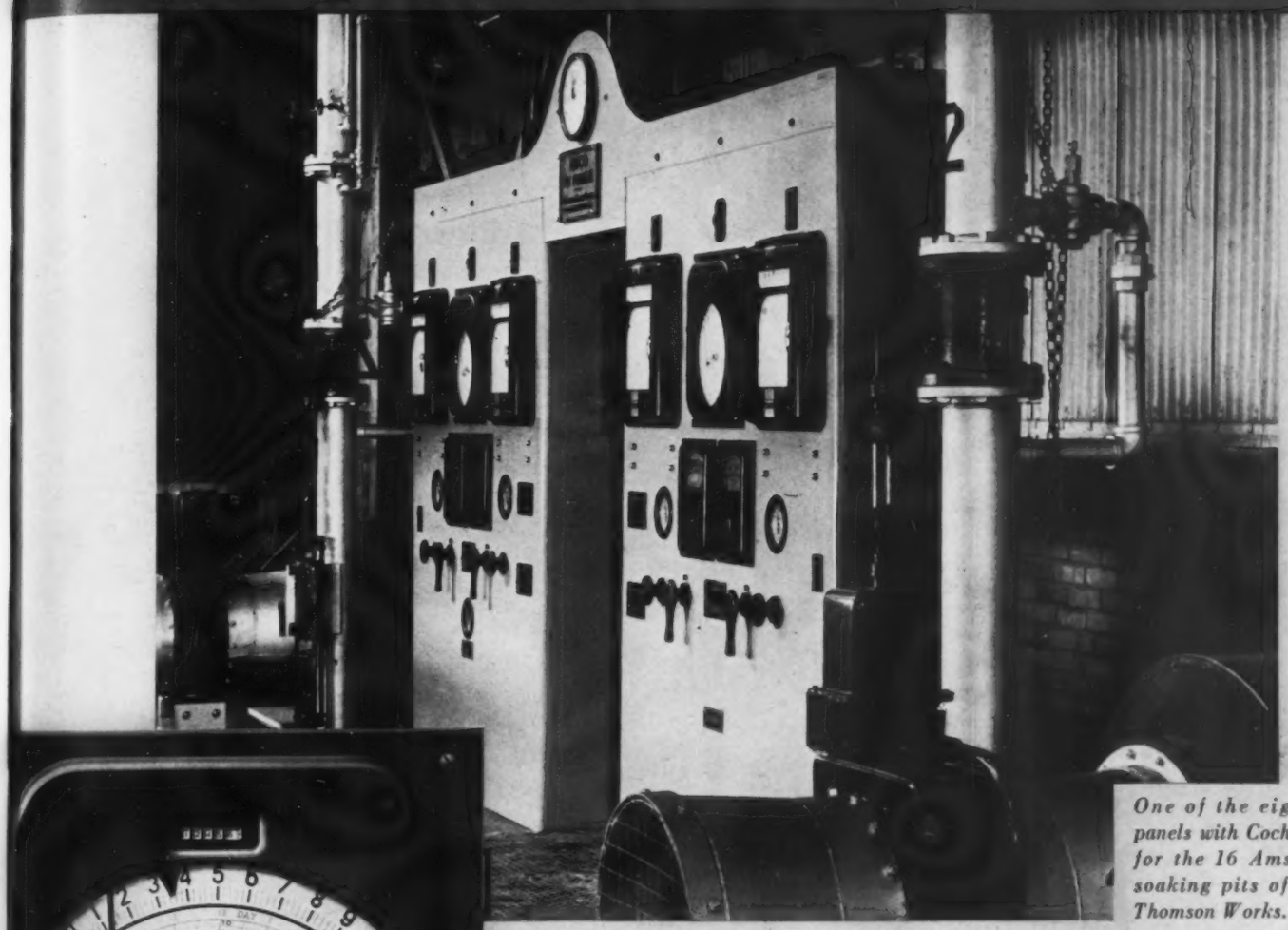
AMCO PIT FURNACES

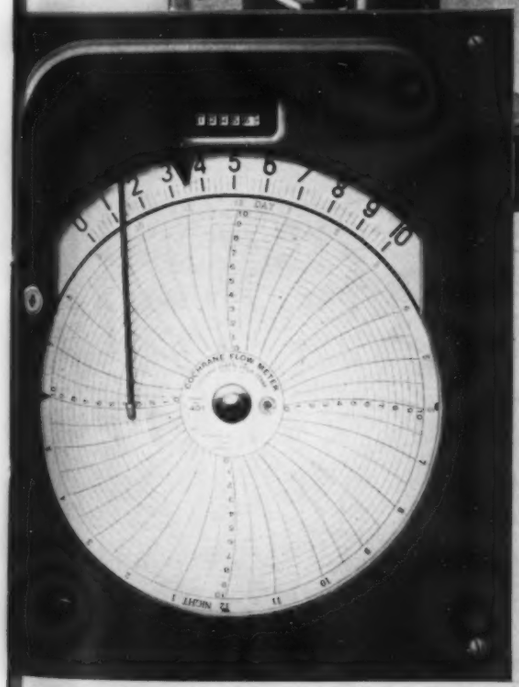


Ask for Bulletin 198, presenting interesting AMCO case-history tests!

The AMSLER-MORTON COMPANY
FULTON BUILDING • PITTSBURGH, PA.

16 Cochrane Gas Meters Measure Flow in Terms of Btu at Edgar Thomson Works—*Carnegie-Illinois Steel Corp.*





One of the eight control panels with Cochrane Meters for the 16 Amsler-Morton soaking pits of the Edgar Thomson Works.

UNIFORMITY is today one of steel's most necessary characteristics and one of industry's most important requirements.

At Carnegie-Illinois' Edgar Thomson Works, 16 Cochrane Electric Flow Meters help to maintain this uniformity. An additional Cochrane Meter is used as a master Btu recorder, measuring Btu content per cubic foot of mixed coke oven and natural gas.

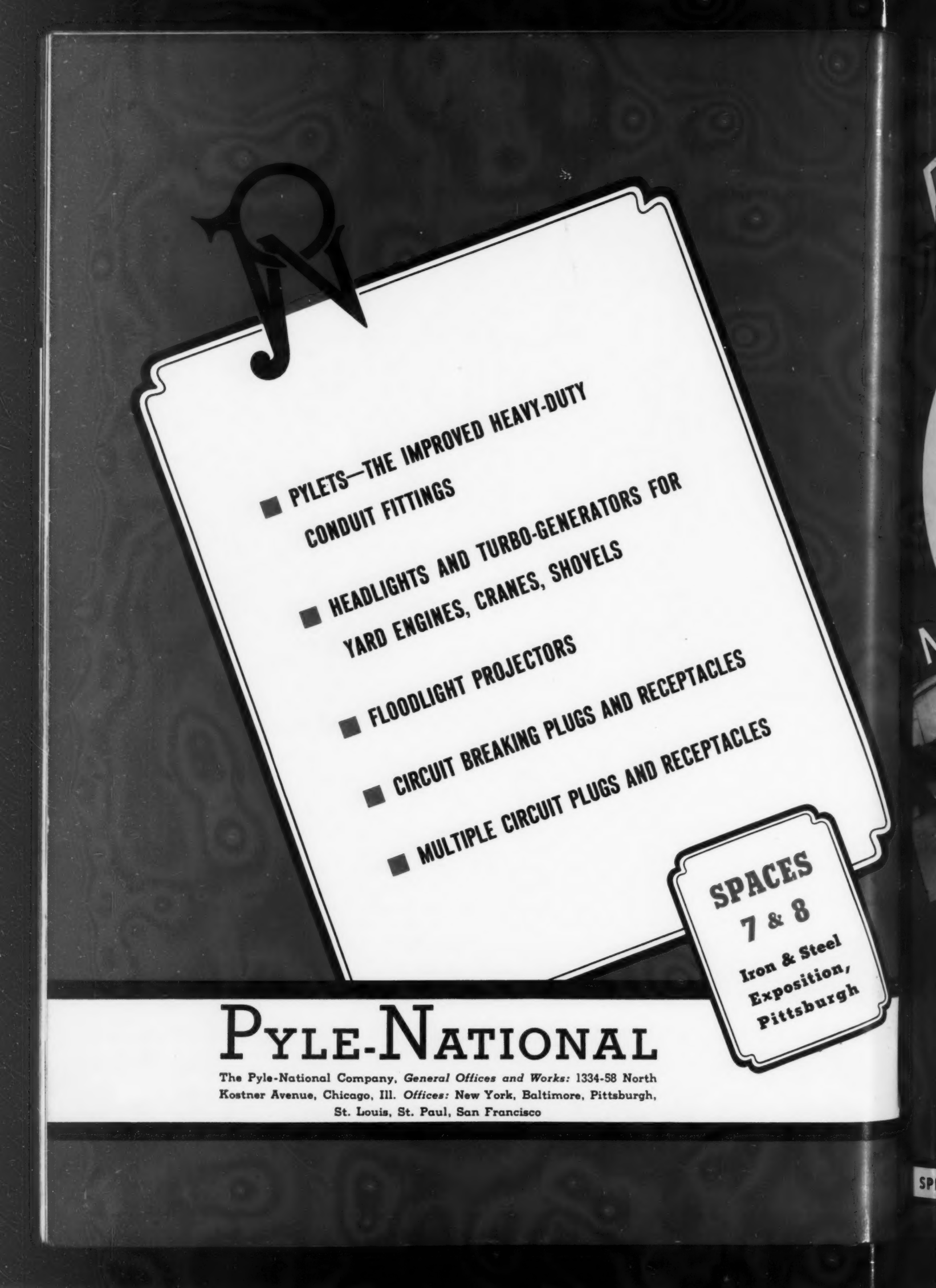
The flow of gas to each of the 16 soaking pits is measured in terms of Btu per hour by automatically compensating the volumetric rate of flow for changes in Btu content of the gas as measured by the master Btu recorder.

Wherever it is necessary to determine the rate of flow of a gas or liquid, you will find Cochrane Flow Meters, both electrical and mechanical, reliable and accurate instruments of measurement. Thousands are in use today by over a hundred different types of industries. Write for Publication 2096.

COCHRANE CORPORATION • 3133 N. 17th ST., PHILADELPHIA, PA.

COCHRANE

TENERS • DEAERATING SOFTENERS • DEAERATORS • METERS • STEAM SPECIALTIES


PYLETS—THE IMPROVED HEAVY-DUTY CONDUIT FITTINGS
HEADLIGHTS AND TURBO-GENERATORS FOR YARD ENGINES, CRANES, SHOVELS
FLOODLIGHT PROJECTORS
CIRCUIT BREAKING PLUGS AND RECEPTACLES
MULTIPLE CIRCUIT PLUGS AND RECEPTACLES
SPACES 7 & 8
Iron & Steel Exposition, Pittsburgh
PYLE-NATIONAL
The Pyle-National Company, General Offices and Works: 1334-58 North Kostner Avenue, Chicago, Ill. Offices: New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco

WEAN

ENGINEERING

Company, Inc.

WARREN OHIO

and its Associate Companies present a pictorial story of their equipment at

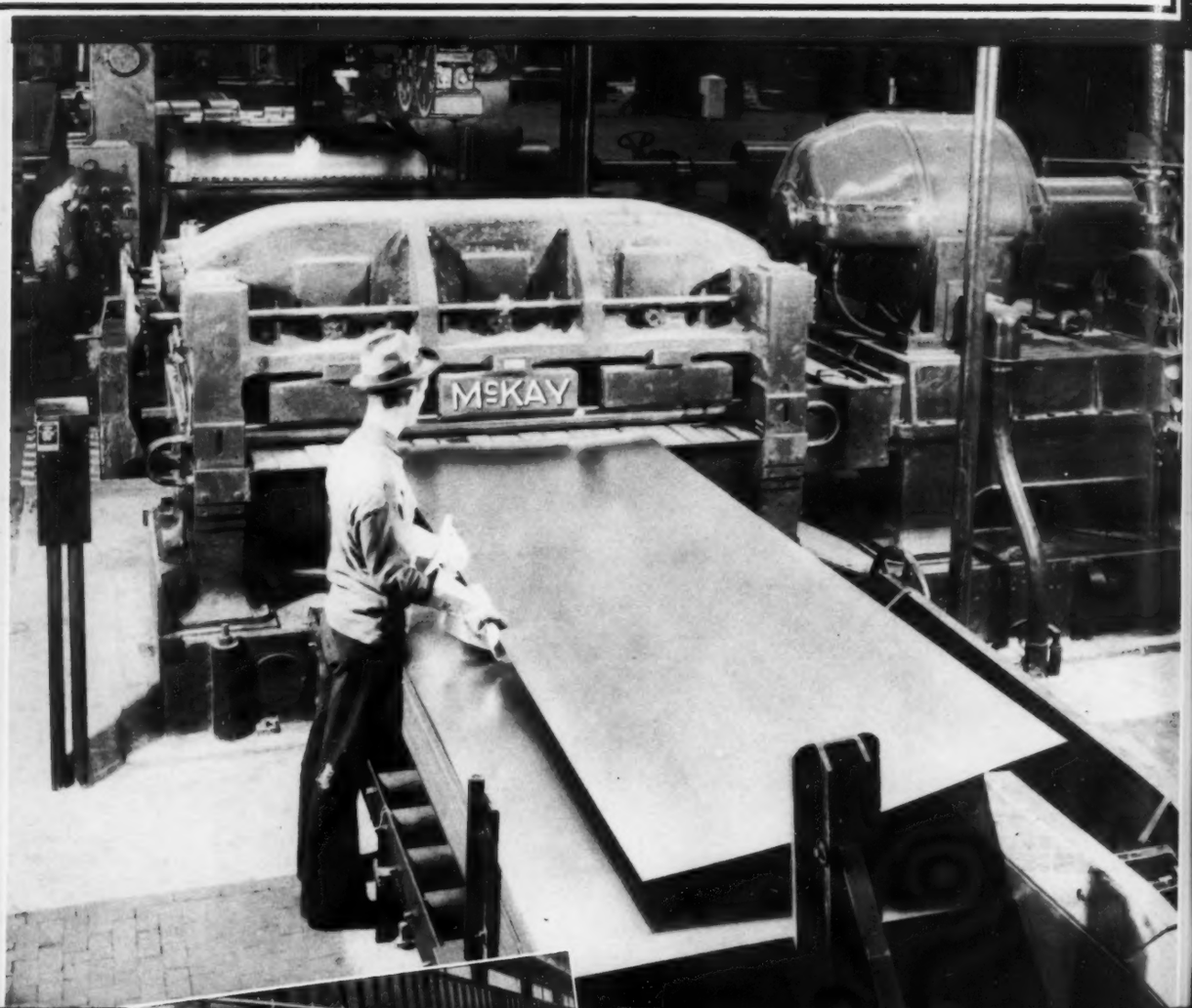
CARNEGIE-ILLINOIS STEEL CORPORATION'S

Notable Achievement

THE NEW IRVIN WORKS

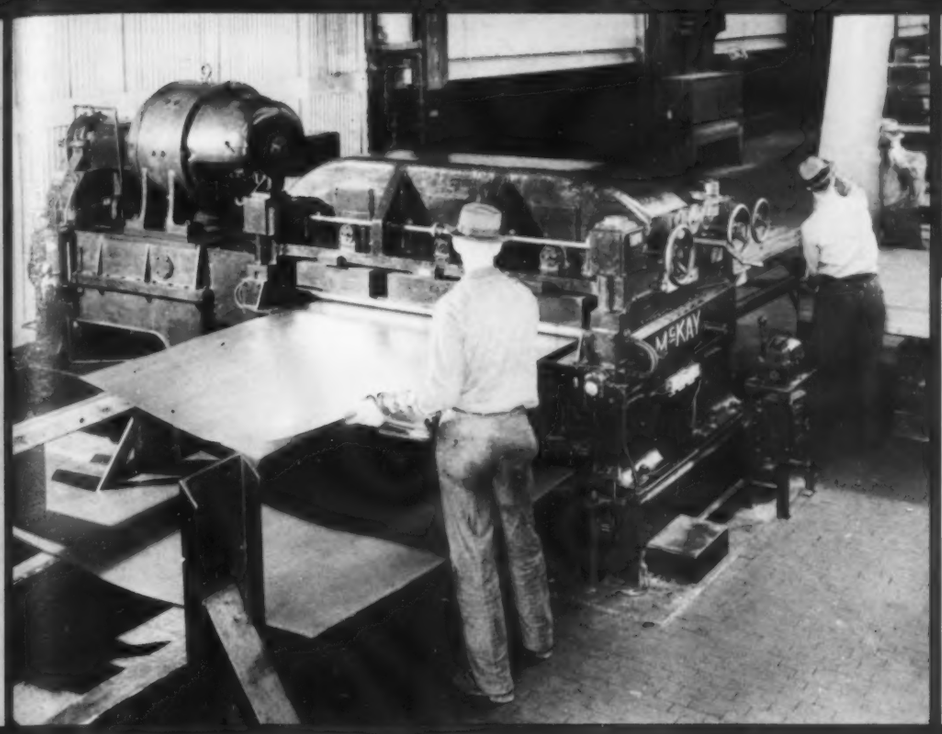
SPECIALISTS IN SHEET STRIP AND TIN MILL EQUIPMENT . . . . . .

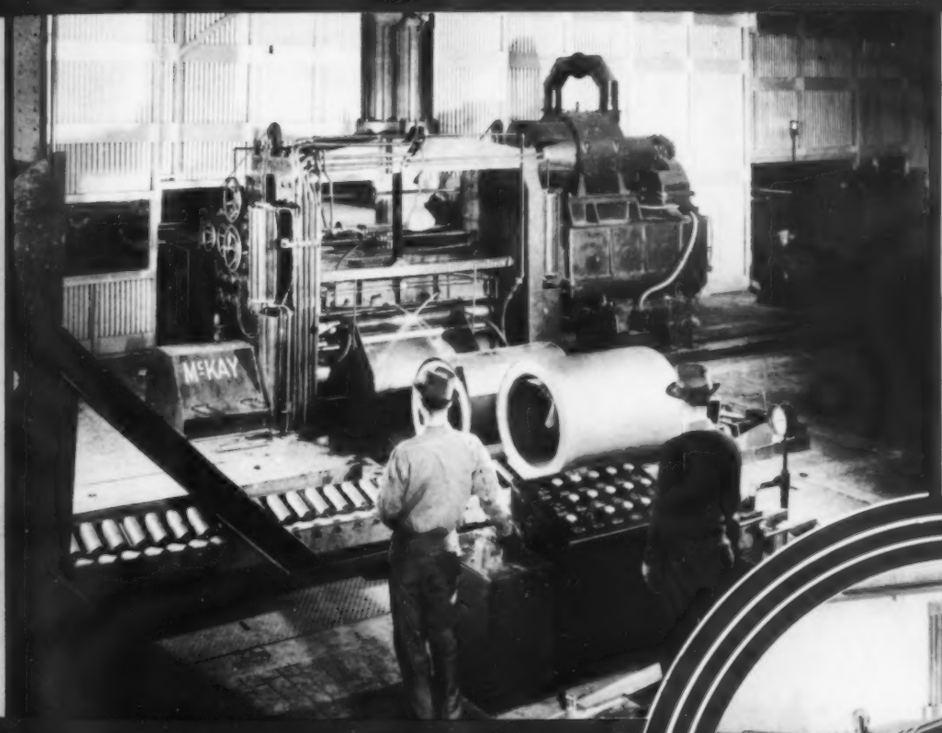
McKAY



The McKay Roller Leveler can not be excelled where accurate flatness is required.

Twenty years' experience in designing and manufacturing equipment for the steel industry insures the quality of workmanship and efficiency of operation that only experience can give.



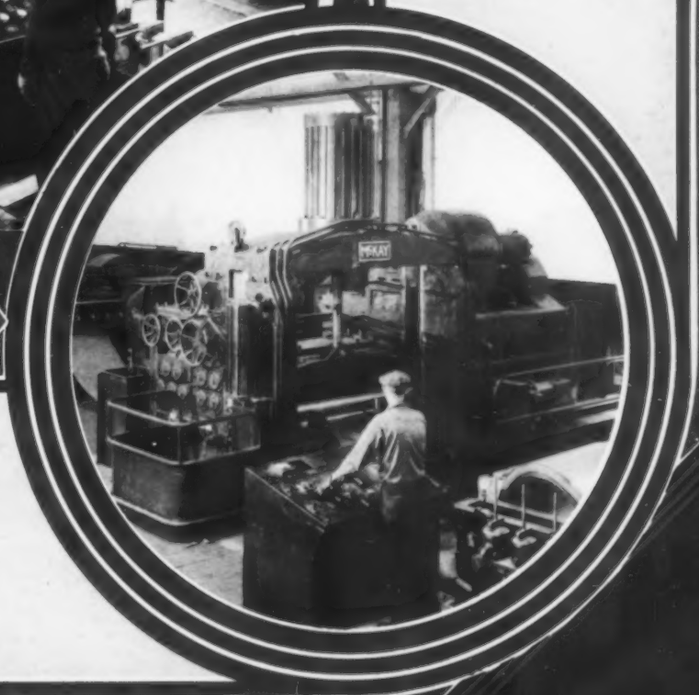


EQUIPMENT FOR THE SHEET AND STRIP INDUSTRY

McKAY

PRODUCTS

- Budd-McKay Sheet Processing Machines
- Two and Four Hi Levelers
- Cold Forming Machines
- Scrubbing Machines
- Oiling Machines
- Strip Uncoilers
- Strip Recoilers
- Scrap Bundlers
- Up-Cut Shears
- Conveyor Tables
- Rotary Slitters
- Sheet Dryers
- Tool Steel Rolls
- Pyramid Benders
- Wrapping Type Benders
- Shape Straighteners
- Drawbenches



Installation of McKay Precoiling Uncoiler. ... uncoiler makes strip more ductile and prevents ... break in forming operations.

THE McKAY MACHINE CO.

Engineers and Manufacturers of

SHEET, TIN AND STRIP MILL EQUIPMENT

YOUNGSTOWN, OHIO

Sold By

THE WEAN ENGINEERING CO., INC., WARREN, O.

The WEAN

ENGINEERING Company, Inc.

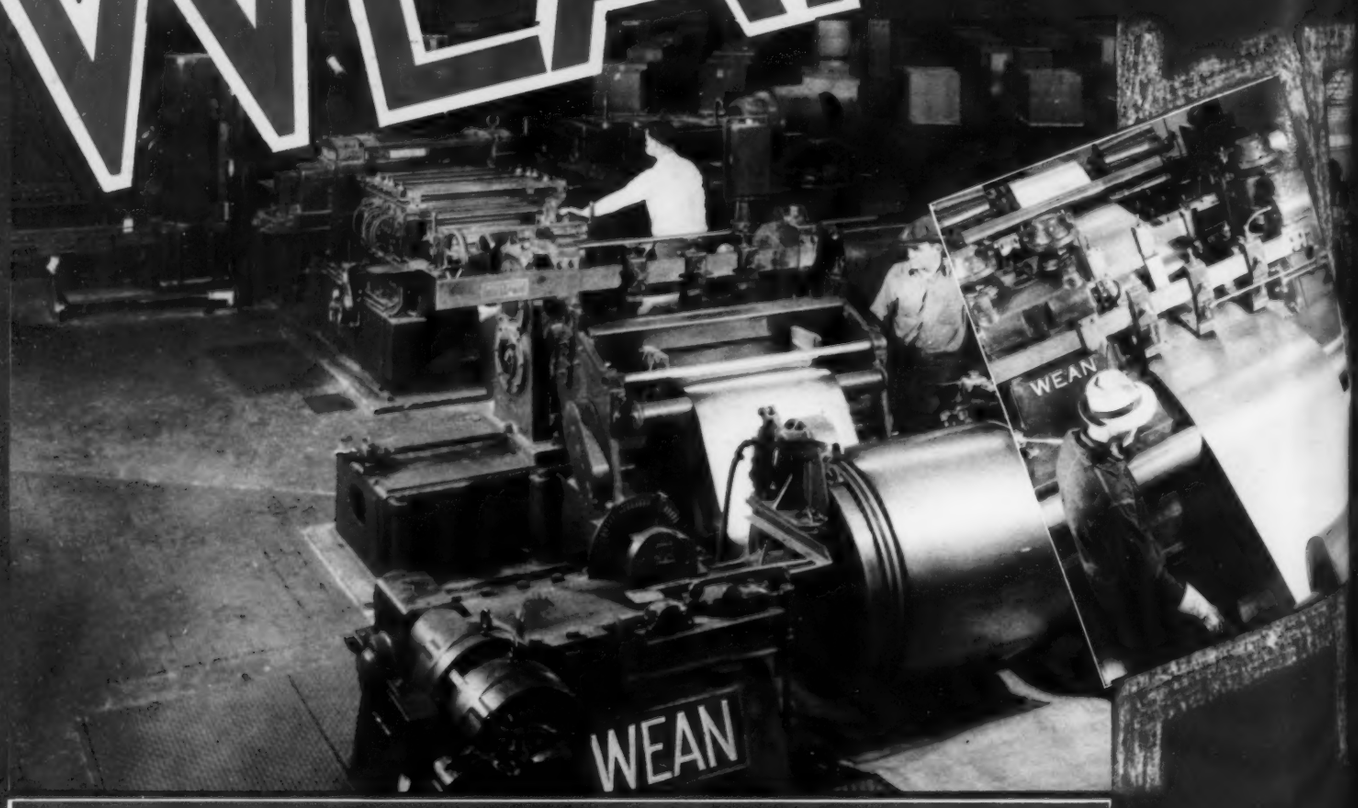
WARREN

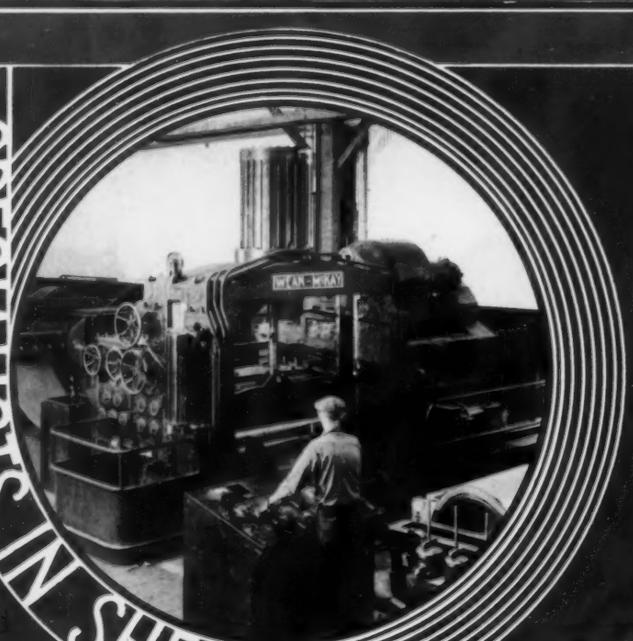
and Associated Companies

Lee Wilson Engineering Co.

The McKay Machine Co.

The Holden Machine Co.



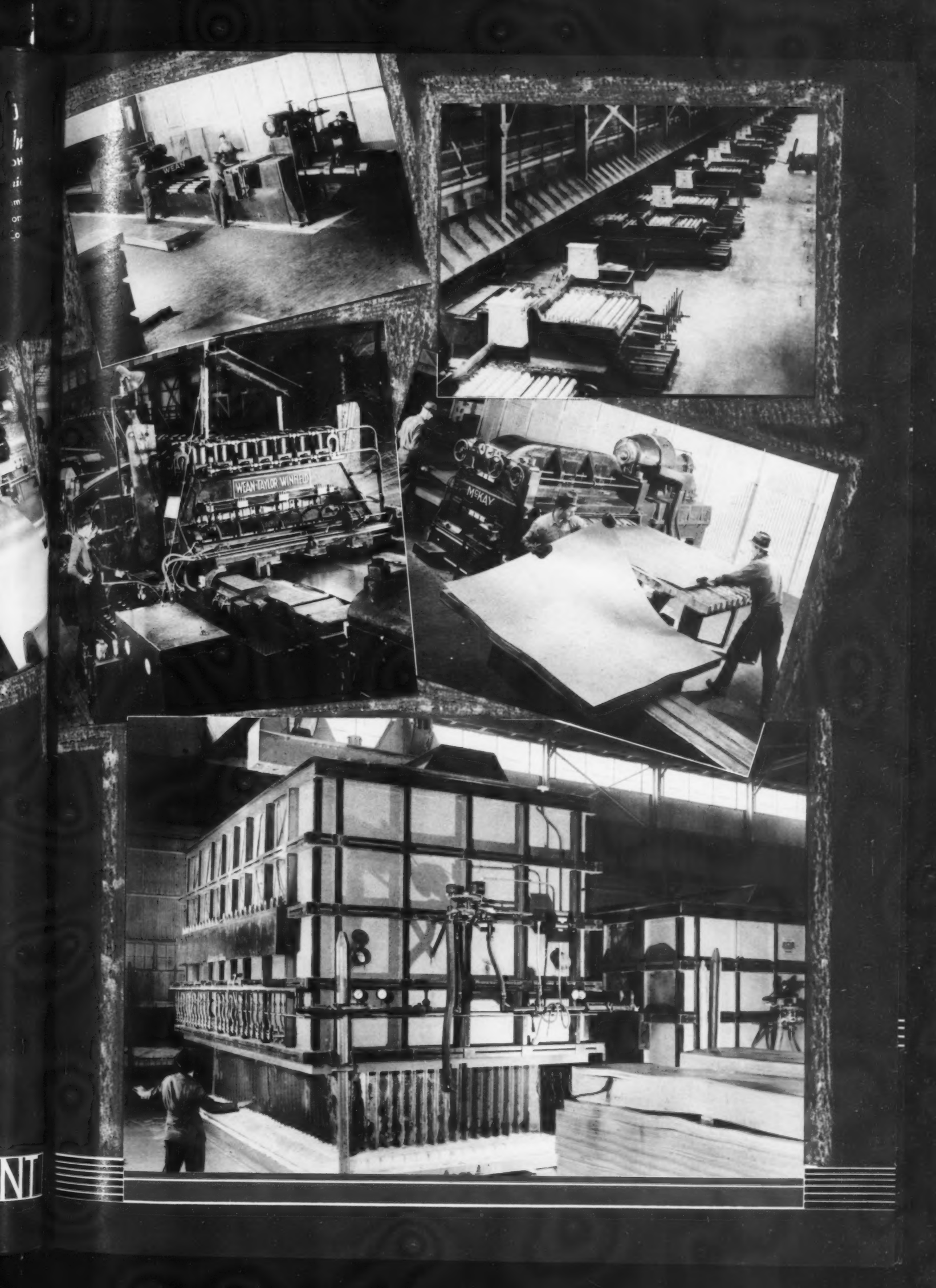


SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT

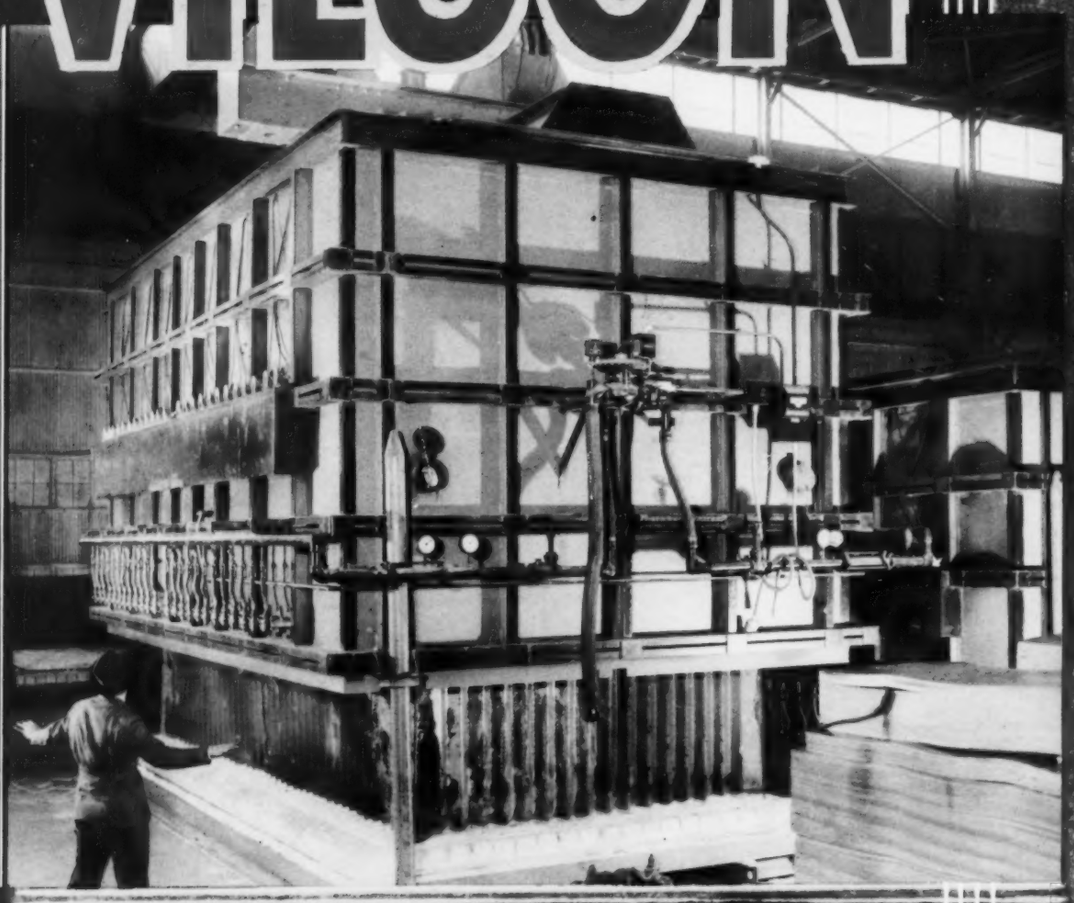
TO better serve the requirements of the trade and to operate at a profit in a highly competitive field, steel plan executives recognize they must have the most modern and efficient equipment available.

The Wean Engineering Company, Inc., Warren, Ohio, is the recognized leader in the design and installation of sheet, tin and steel mill equipment, whether it be one piece or a complete unit.

Many steel mill executives, both in this country and abroad, have recognized the advantages and efficiency of WEAN SHEET, STRIP AND TIN MILL EQUIPMENT. The same recognized advantages are available for overcoming your problems.


WEAN
WEAN-TAYLOR-WINFIELD
McKAY

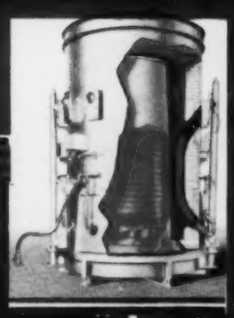
WILSON



WHEN the new Works of Carnegie-Illinois Steel Corporation, at Joliet, Illinois, went into operation, 16 more Lee Wilson annealing units joined with vertical radiant tubes, swung into operation.

With a tradition of extraordinary uniformity of annealing, low operating costs, and speed to meet mill requirements, this new installation has fully justified the confidence placed in its designers.

The experience acquired in building equipment which has annealed [illegible] tons of steel, serves them as an old friend.



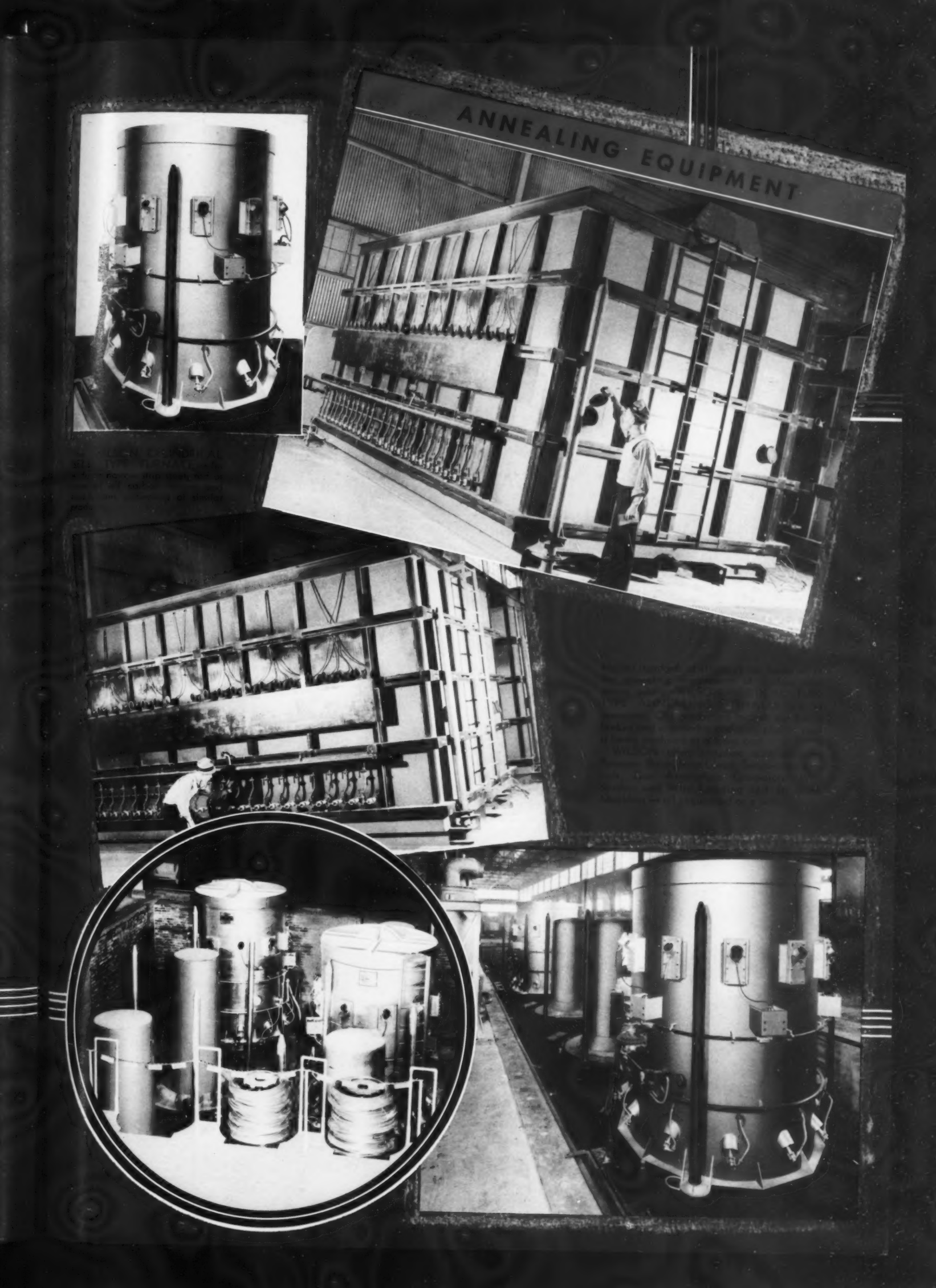
An Exclusive Development of

LEE WILSON ENGINEERING CO.

1570 Ellsworth Street • • • Cleveland, Ohio

SOLD BY

THE WEAN ENGINEERING CO., INC., WARREN, O.


ANNEALING EQUIPMENT

HALLDEN

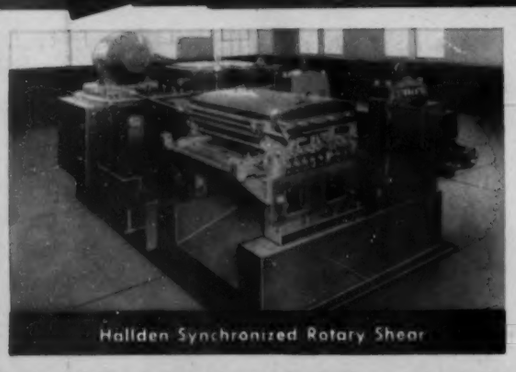
STEEL MILL EQUIPMENT

ROTARY and ROCKER HEAD SYNCHRONIZED FLYING SHEARS

ACCURACY plus HIGH SPEED plus LOW MAINTENANCE plus LOW COST

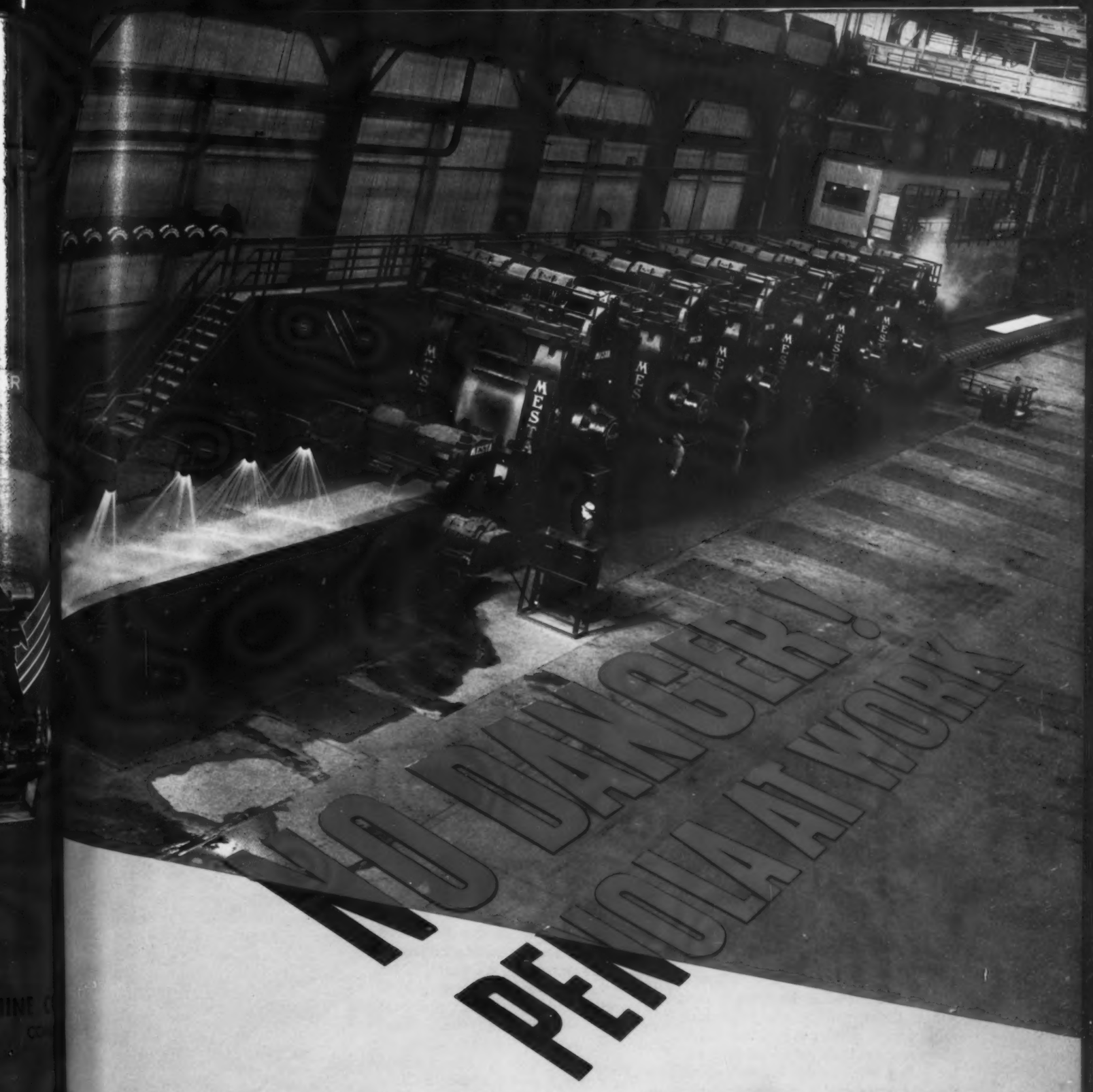
THE HALLDEN MACHINE CO.
THOMASTON CONN.

SOLD BY
THE
WEAN ENGINEERING COMPANY, INC.
WARREN - - - OHIO


Hallden Synchronized Rotary Shear

Hallden Synchronized Rocker Head Shear

HALLDEN · SYNCHRONIZED FLYING SHEARS COMBINE HIGH SPEED WITH EXTREME ACCURACY



WHEN you visit Carnegie-Illinois Corporation's Irvin Works during the Convention, inspect their new 80″ Continuous Hot Strip Mill. Penola lubricants and greases play a vital role in this modern mill!

The circulating system that protects the pinion gears and bearings on the 80″ Continuous Hot Strip Mill uses Penola lubricants *exclusively*. Moreover, Penola supplies all greases for anti-friction bearings throughout this mill, as well as for screw-down lubrication. That's a big order. But Penola is used to filling big orders for the Steel industry.

No matter what type of lubricant you need in *your* mill, Penola not only meets your most rigid specifications... but allows a *margin of safety* that means the difference between disastrous metal-to-metal contact and frictionless operation!

More Penola steel mill lubricants are produced and sold than any other make in the world. Penola's lubrication engineers stand ready at any time to aid you in solving your lubricating problems. Let Penola help you to cut your overhead!

PENOLA LUBRICANTS

PENOLA INC., PITTSBURGH, PA. • (FORMERLY PENNSYLVANIA LUBRICATING CO.) • NEW YORK, CHICAGO, DETROIT, ST. LOUIS

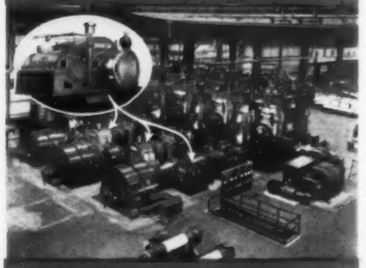
LUBRICANTS FOR THE STEEL INDUSTRY SINCE 1885

One of Six 30" x 168" Farrel Roll Grinders installed in new Irvin Works.

In Visiting the New Irvin Works SEE THE . . .

FARREL Heavy Duty Roll Grinders and Drives

Farrel-Sykes Continuous Tooth Herringbone Gear for rolling mill drive. 117.480" diameter, 25" face.



Two 2500 H.P. and one 3500 H.P. Farrel Gear Units driving 84" Tandem Cold Mill in Irvin Works.

The new Irvin Works of Carnegie-Illinois Steel Corporation are to be inspected by visitors to the Iron and Steel Exposition at Pittsburgh. On your tour of this plant don't fail to see the six Farrel Heavy Duty Roll Grinders installed there.

Note the speed and accuracy with which these roll grinders produce rolls of high precision and fine finish; observe how they grind perfect surfaces free from all marks, with either straight, concave or convex contours of exact symmetry. They take, with equal facility, heavy cuts for rough grinding or apply the finest mirror finish. Notice, too, their smooth, vibrationless operation.

You will also be interested to watch the operation of the Farrel Gear Units which drive an 84" three-stand tandem cold reduction mill and 54" reversing mill at the Irvin Works. Typical examples of the advanced engineering and precision construction characteristic of all Farrel Gear Units, these drives are ruggedly built to stand the stresses, shocks and wear incident to high speeds and heavy loads.

Ask our engineers at Booth 71 of the Iron and Steel Exposition to explain the details of design and construction responsible for the efficient, economical, dependable performance of Farrel Roll Grinders and Drives under the severest operating conditions.

Visit FARREL Booth 71
IRON & STEEL EXPOSITION
PITTSBURGH
September 26-29, 1939

FARREL-BIRMINGHAM COMPANY, Inc.

Ansonia, Conn. · Branch Offices: Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles

Designed and Built by

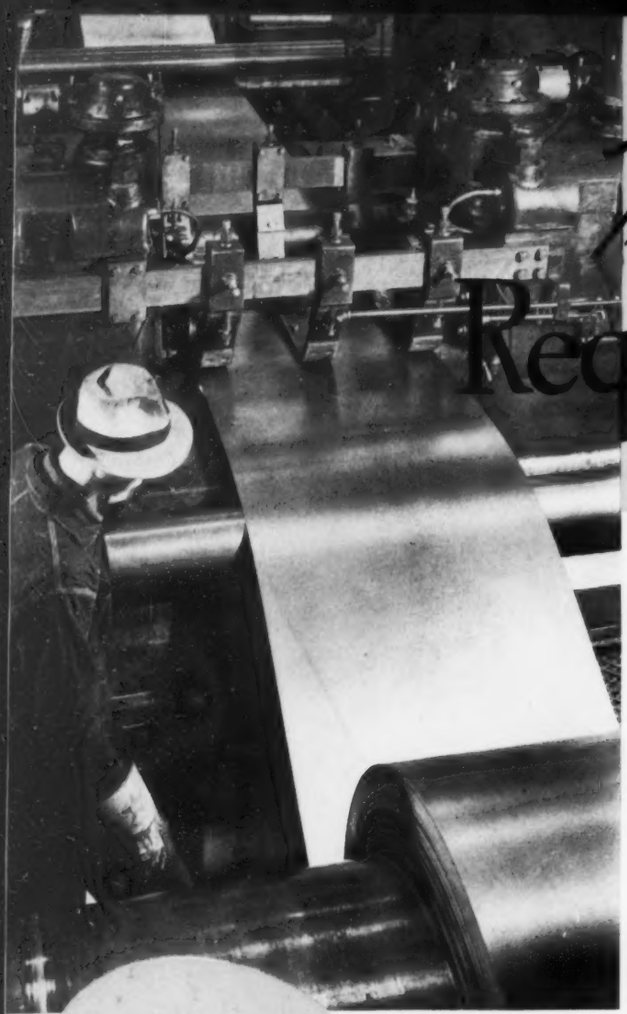
Alliance

Designed and built by ALLIANCE (Largest Builders of the World's Largest Cranes) the 40-ton, 120′ span, Electric Overhead Traveling Crane shown above is one of eight built by ALLIANCE for the New Irvin Works of Carnegie-Illinois Steel Corporation.

ALLIANCE designs and builds Ladle Cranes, Ingot Strippers, Soaking Pit Cranes, Open Hearth Charging Machines, Slab and Billet Charging and Drawing Machines, Standard Cranes, Gantry Cranes, Ore and Coal Bridges, Car Dumpers, Forging Manipulators, Board and Steam Drop Hammers, Coal Pier Equipment, Rolling Mill Machinery and Special Machinery . . . all to your individual requirements.

THE ALLIANCE MACHINE COMPANY

Designers and Builders ALLIANCE, OHIO

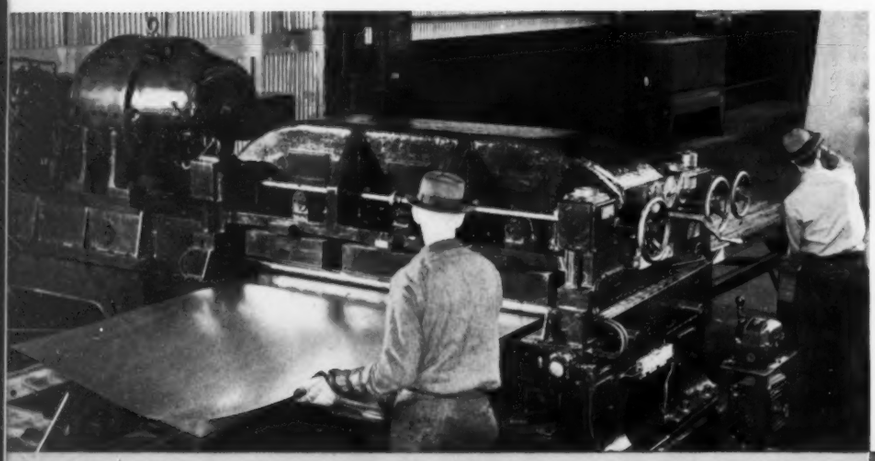


PHOTOS BY COURTESY OF CARNEGIE-ILLINOIS STEEL CORPORATION, IRVIN WORKS

The FINISHING Requires Motor-Drive

IN these pictures you see typical answers to new finishing problems which continuous rolling has brought to mill men and equipment builders. They are ingenious answers setting new standards for tonnage and quality.

Here are up-to-the-minute examples of making motor-drive mean a lot more than power, of getting it to play a real part in production. This and many similar installations represent Reliance experience which can help you get a running start when you have jobs like this ahead of you. We shall be glad to lend you a hand.

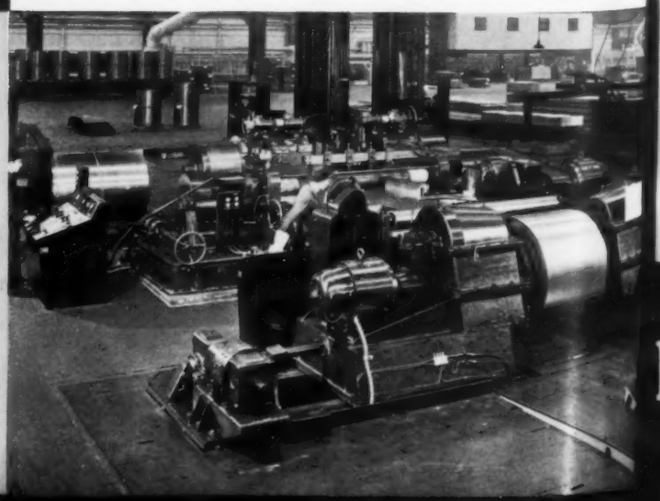


Levelling

McKay Backed-up Leveller for wide sheets driven by Type T Adjustable-speed Reliance Motor with ball bearings. A 2 to 1 speed range gives the desired operating speeds for ironing out any uneveness due to either hot or cold rolling. Sheets are so thoroughly worked that they are smooth, flat, and ductile.

Trimming—Recoiling

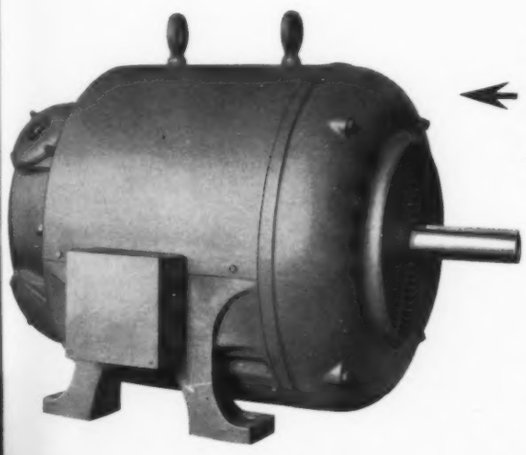
A Reliance Synchronized Drive is used for this Side Trimming and Recoiling Line (Wean) for wide strip. Eleven d-c. and a-c. motors, each designed with characteristics to suit its task, team up for elevating the coil into position, cone adjustment, uncoiling, side trimming and recoiling. Uncoiler, slitter and recoiler motors operate in tandem. Speeds of 100-400 f.p.m. are obtained by voltage control. . . . The drive provides for maintenance of constant tension by compensating for diminishing coil diameter on uncoiler and coil build-up on recoiler. Tensions approximating 4000 lbs. can be established on the strip during recoiling.



TOUCH • • • that is *More than Power!*

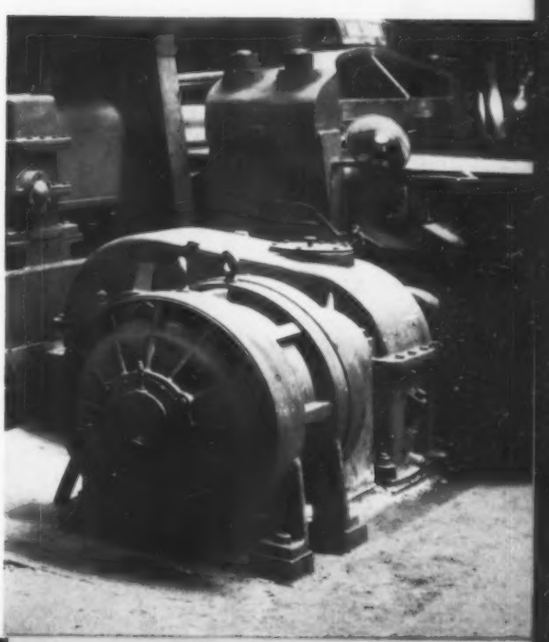
Pickling →

Delivery end of Wean Continuous Strip Pickling Line for wide material. Forty Reliance Motors (d-c. and a-c.) along this 600-foot line help to perform operations which call for a variety of features such as, speed variation, tandem operation; quick acceleration and deceleration; ability to handle peak overloads; centralized and remote control; safety—all factors which contribute to top-notch production, quality and steady operation.



Enclosed, Fan-cooled D-c. Type T Heavy-duty Reliance Adjustable-speed Motor as used for upcoiler and follower pinch rolls of continuous strip pickling line. ←

50 hp. Enclosed Squirrel-cage Type AA Reliance Motor with special torque characteristics for shears and stitchers. →



RELIANCE ELECTRIC & ENGINEERING COMPANY
1087 Ivanhoe Road Cleveland, Ohio

Branches—Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Greenville (S. C.), Los Angeles, New York, Philadelphia, Pittsburgh, Portland (Ore.), St. Louis, San Francisco, Syracuse (N. Y.) and other principal cities.

RELIANCE A-C D-C MOTORS

MOTOR-DRIVE is *More Than* Power

The steel industry knows this name plate well!

ESTABLISHED 1899

THE TRUMBULL ELEC. MFG. CO.

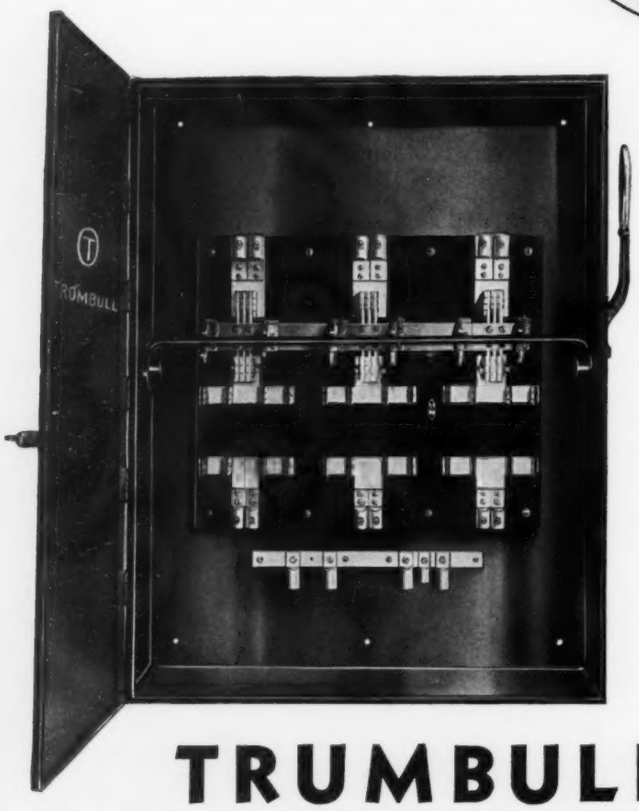
PLAINVILLE CONN. U.S.A.

A GENERAL ELECTRIC ORGANIZATION

TRUMBULL

TYPE "A"

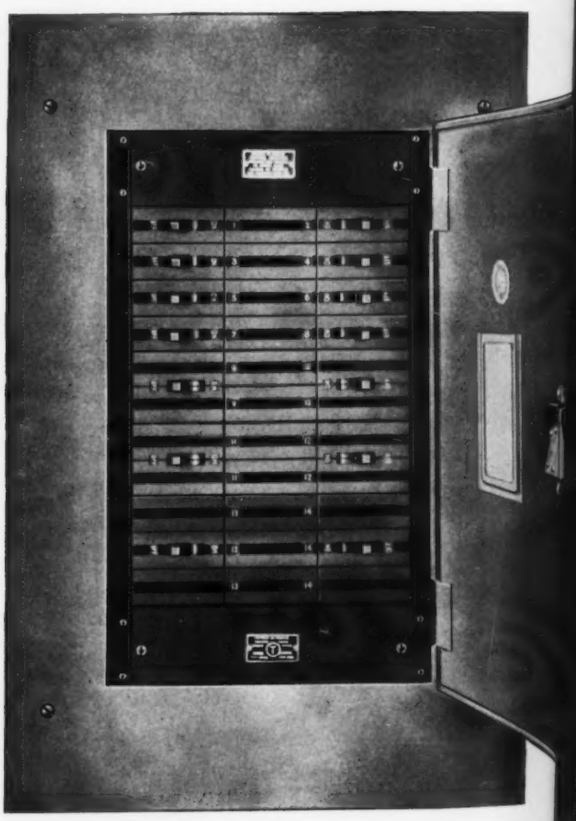
HEAVY DUTY SAFETY SWITCHES



exactly meet the requirements of steel mill service, incorporating the progressive improvements of Trumbull's long experience in this field.

As required by most plant regulations, switch blades can be inspected under load by authorized persons. Every detail in design and construction of Trumbull Type "A" Switches will meet highest standards for both electrical and mechanical efficiency.

For complete description, specifications and listing of special features available in this importantline send for new Type "A" Switch Circular No. 302.



TRUMBULL

CIRCUIT BREAKER PANELBOARDS

For Light and Power Service

Installed in many steel mills where automatic short circuit and overload protection is desired for each branch circuit.

Outstanding features include simple, rugged unit breaker mechanisms each enclosed in molded bakelite case . . . sealed against tampering . . . safe . . . attractive in appearance.

Breakers easily removed from front of panel without disturbing adjacent units. Extremely wide range of standard and special combinations possible.

For full details, specifications, etc., see Trumbull Circuit Breaker Panelboard Circular No. 164.

THE

TRUMBULL

ELECTRIC MANUFACTURING COMPANY

PLAINVILLE — A GENERAL ELECTRIC ORGANIZATION — CONNECTICUT

Right ON THE JOB

PRODUCTS THAT ARE RIGHT FOR THE JOB . . . SERVICE THROUGH WHOLESALERS AND CONTRACTORS WHO ARE RIGHT ON THE

LE CARBONE BRUSHES

. . . . A VITAL CONTRIBUTION TO DEPENDABLE OPERATION

• In the Pittsburgh district, as in other locations, you will find Le Carbone Brushes delivering uniformly efficient and reliable brush performance on a great variety of tough jobs—a most important contribution to dependable operation of electrical machinery.

On heavy-duty mill motors, or the smallest auxiliaries, remember it is the brushes that carry the load, and Le Carbone Brushes that have for more than 60 years set the standard of uniformity, quality, and efficiency.

•

LE CARBONE COMPANY, INC.

BOONTON, NEW JERSEY

NEW YORK • PITTSBURGH • CHICAGO
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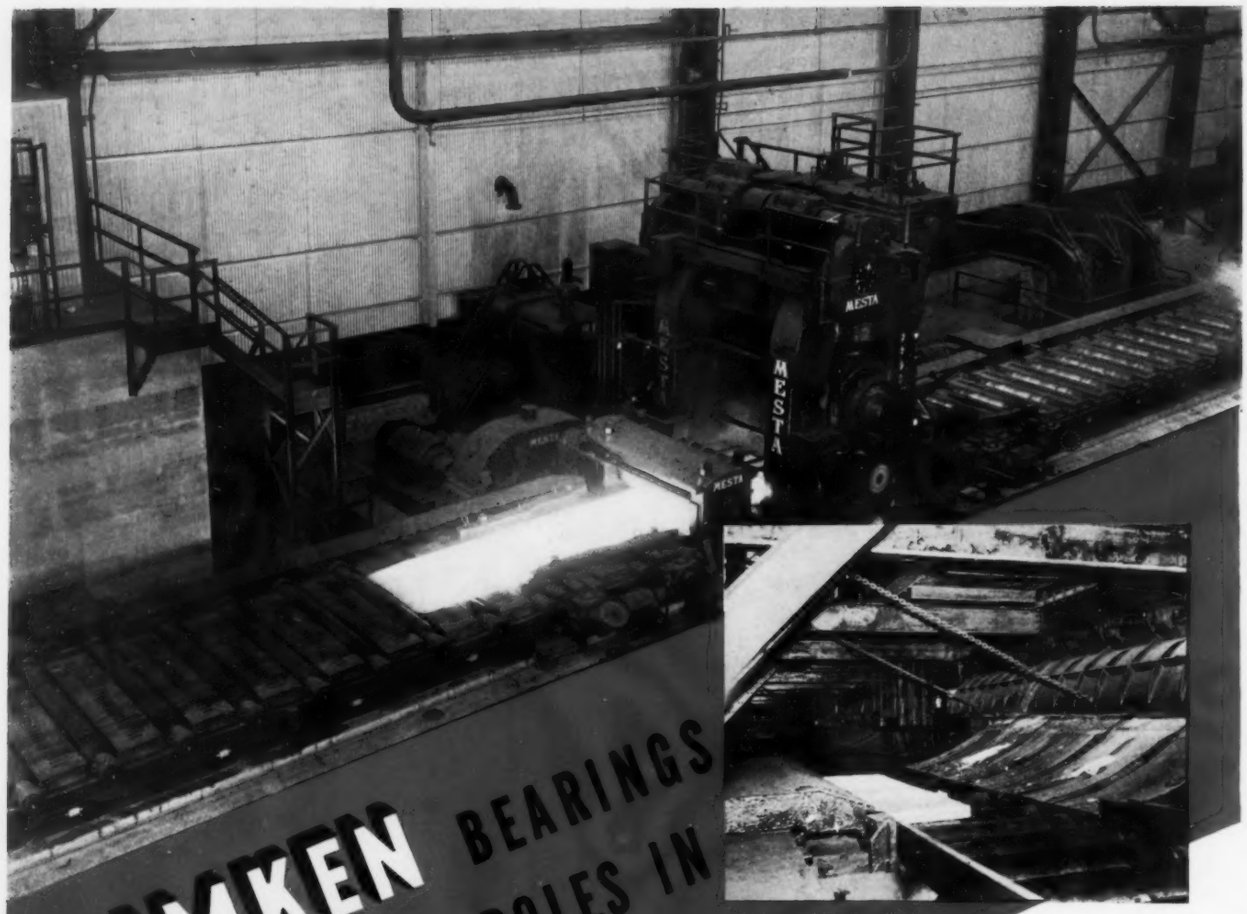
Space 107

IRON & STEEL EXPOSITION • PITTSBURGH •



TIMKEN BEARINGS HAVE IMPORTANT ROLES IN NEW 80" HOT STRIP MILL

Timken Bearing Equipped tables in new 80" hot strip mill.

On TIMKEN BEARINGS

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN

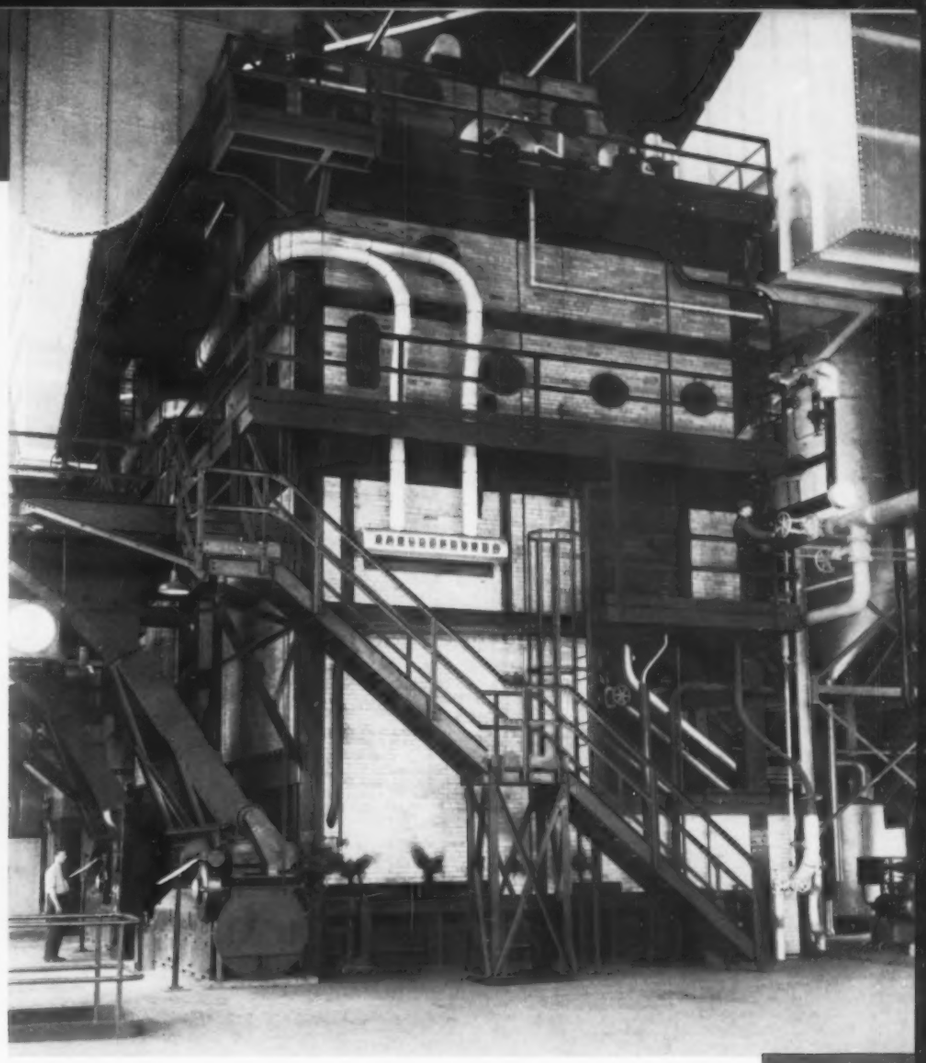
TAPERED ROLLER BEARINGS

Many TIMKEN Tapered Roller Bearings are used in main and auxiliary equipment of the new 80" continuous hot strip mill described in this issue of "The Iron and Steel Engineer".

These applications include: work rolls, mill and edger drives, screwdowns, table rolls, reels, shears, slitters, electrolytic cleaning lines, cranes, processing units and other equipment.

The advantages of TIMKEN Bearings in the table rolls are of particular importance to mill operators in view of the conditions prevailing in modern mill operation, where high speeds, heavy loads, heat and shock combine to make bearing service extremely severe.

TIMKEN Bearing applications designed especially for this work are performing efficiently, economically and uninterruptedly in strip, sheet and bar mills of all kinds. You can have TIMKEN Bearing benefits in your mill tables—old or new. Consult the equipment builder or Timken engineers.



Combination coke and gas fired boilers at Irvin Works, Carnegie-Illinois Steel Corp.

DRAVO

BUILT THE COMPLETE BOILER PLANT

for "The Most Modern Mill in the World"

EQUIPMENT includes waste heat and fuel fired boilers; complete water treating system for 100% makeup; softener, filter and deaerating units, hydraulic ash handling system, coal handling and storage, automatic combustion control, instruments and accessories.

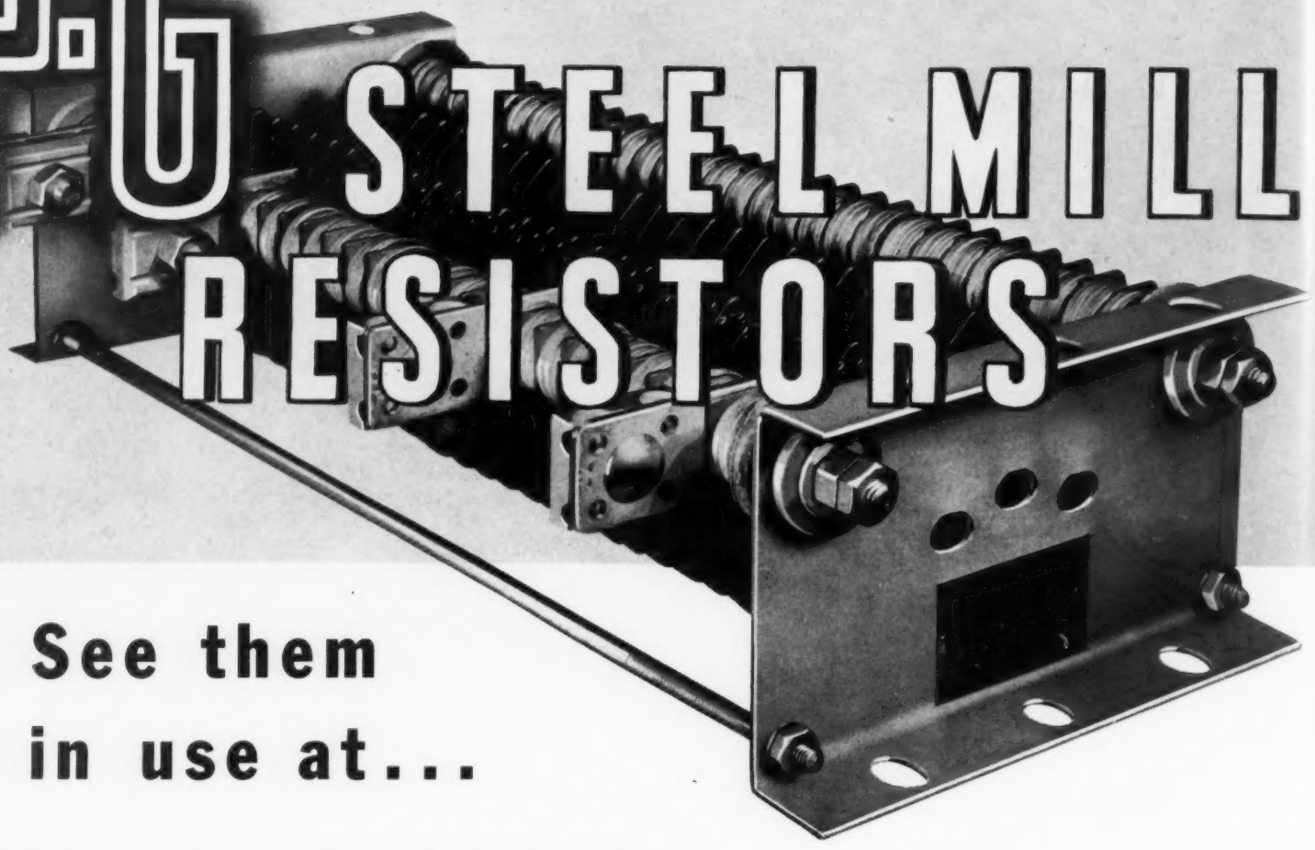
DRAVO CORPORATION

Machinery Division

300 PENN AVENUE PITTSBURGH, PA.

BRANCH OFFICES IN PHILADELPHIA, PA. AND CLEVELAND, OHIO

P-G STEEL MILL RESISTORS



See them in use at...

THE IRVIN WORKS

The Alliance Cranes are equipped with P-G Steel Grid Resistors.

EDGAR THOMSON WORKS

The Charging Machines in the New Mill are equipped with P-G Steel Grid Resistors.

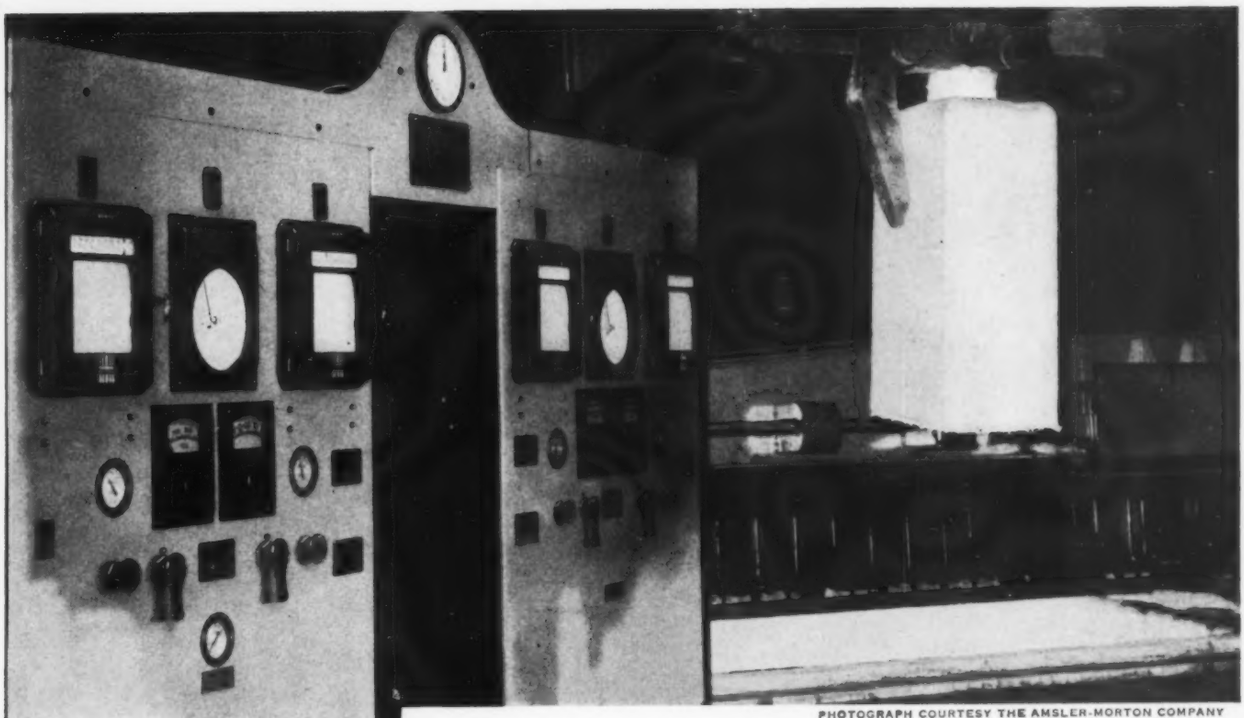
Visit us at Booth No. 1 at the Iron and Steel Exposition and let us tell you more about

STEEL GRID RESISTORS

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO



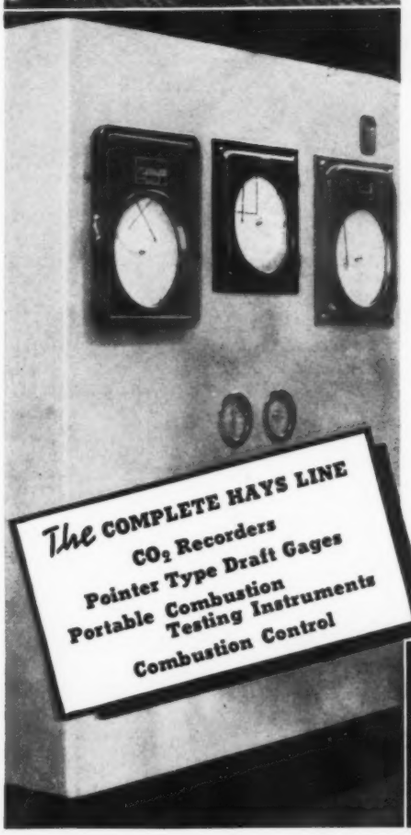
PHOTOGRAPH COURTESY THE AMSLER-MORTON COMPANY

They "see" what's going on in the soaking pits—

HAYS COMBUSTION INSTRUMENTS AND CONTROL INDICATING AND RECORDING INSTRUMENTS ACCURATELY DEPICT GAS PRESSURE, FURNACE PRESSURE, AIR FLOW

In the above installation a Hays "OT" Recorder (panel at the left) accurately records the gas pressure for every minute of the day and night. An Air Flow indicator (upper panel) shows continuously the air volume and flashes a warning signal when it reaches 25% of the load or lower. At the same time a Hays "D" Gage indicates the pressure *inside* the furnace. Thus is guesswork and uncertainty eliminated.

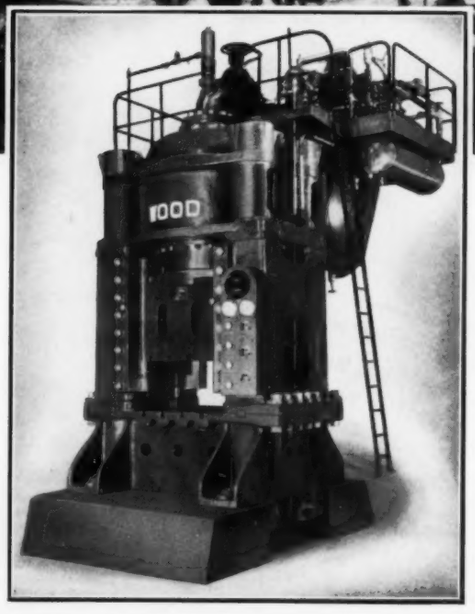
Hays Combustion Instruments have set the standard for accuracy, dependability and stamina for 38 years. They are as well known in the steel mills and power plants of the country as a monkey wrench. They can be designed to meet practically any requirement concerning indicating, recording and controlling of combustion conditions. Hays Engineer-representatives are located in all the principal cities to help industry in the solution of its combustion problems. They will be glad to serve you. Write to 955 Eighth Ave., Michigan City, Indiana.



The HAYS CORPORATION

SINCE 1901 — COMBUSTION INSTRUMENTS AND CONTROL — MICHIGAN CITY, INDIANA, U.S.A.

CONTROLLED POWER...



The ease and accuracy with which huge forces are controlled in R. D. WOOD equipment is but one of many reasons why the name WOOD is highly regarded by those who use hydraulic presses.

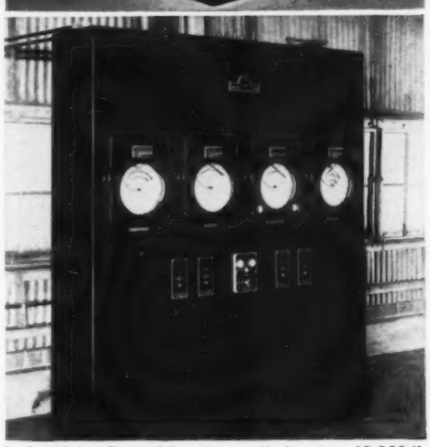
R. D. WOOD CO.

PHILADELPHIA • PENNSYLVANIA

HYDRAULIC PRESSES AND VALVES FOR EVERY PURPOSE

IRVIN WORKS
INSURES STEAM ECONOMY

Automatic Operation by *Bailey Meter Control* Continuously Secures Fuel Economy, Boiler Safety and Plant Reliability



Bailey Meter Control Panels installed on two 60,000 lb. per hour capacity boilers fired with coke breeze and coke oven gas, Irvin Works, Carnegie-Illinois Steel Corp.

• At Irvin Works of Carnegie-Illinois Steel Corporation Bailey Meter Control automatically operates two boilers fired with coke oven gas and coke breeze. It also regulates draft to two waste heat boilers and controls treatment of raw river water. In addition, Bailey Meters measure the flow, pressure, and temperature of steam, feed water, coke oven gas, natural gas, flue gas, and service water.

It is by the use of meters and controls of this type that power plant operators can secure a full return on investments in major equipment such as boilers, stokers, and pulverizers.

Because of the continuous fuel economy, the added boiler safety, and the added plant reliability which they afford, meters and controls are one of the few "high return" investments open to power plant owners today. Send for a copy of Bulletin No. 102-B. It describes Bailey Control.

A-53

BAILEY METER COMPANY
1047 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada

BAILEY METER COMPANY

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

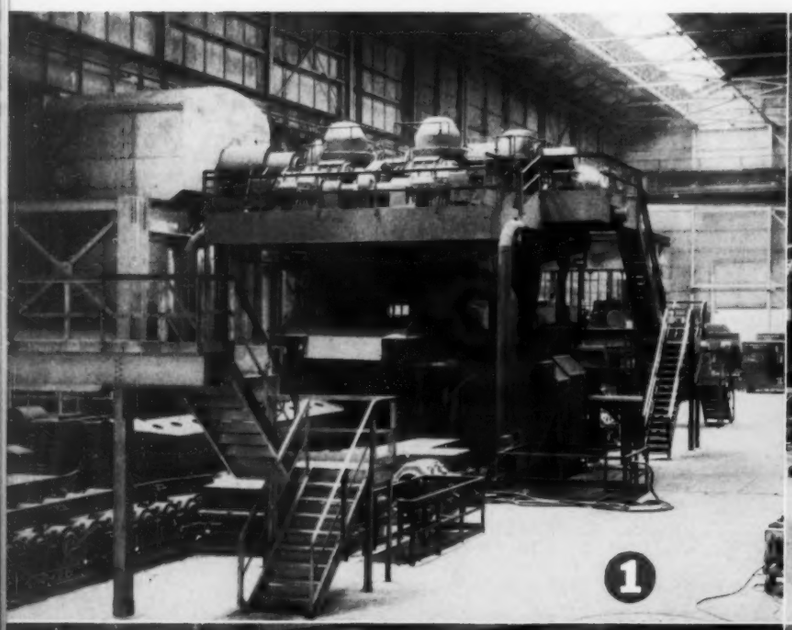
On YOUR TRIP *Through Edgar Thomson and Irvin Works* YOU WILL FIND

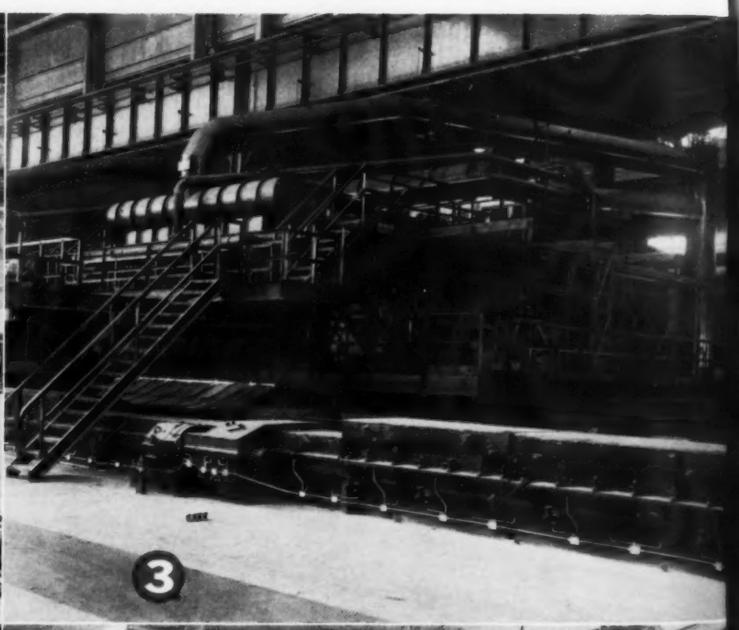
Trabon *Positive Lubrication* On the Job

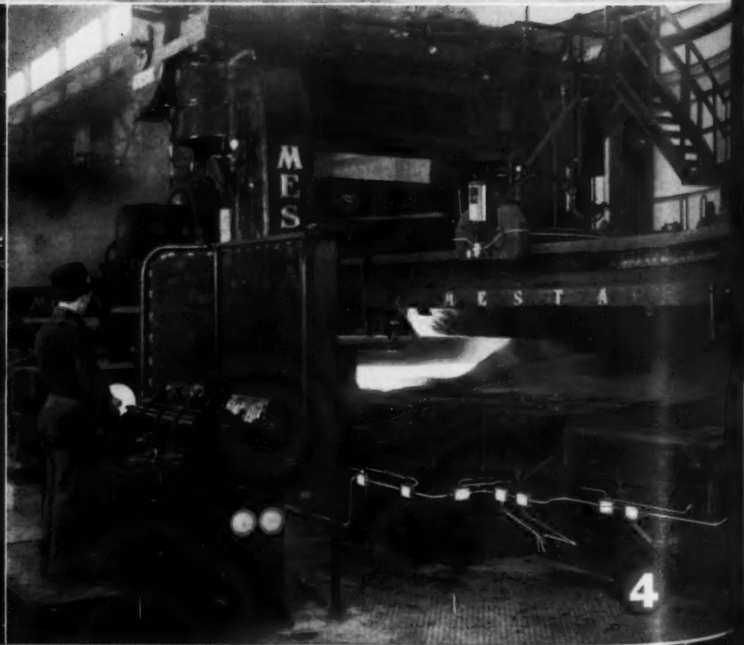
from SLABS *to* STRIP

Positive Lubrication =

Trabon is the single line system with only one "tells all" indicator. You will find it at the pump—where it can be seen. It appears only after all of the feeders in the circuit have delivered their measured quantities of lubricant, and its operation shuts off the pump motor. No pressure gauges are needed.







1. *45" x 80" Slabbing Mill.*

2. *Slab Shear Gauge.*

3. *Furnace Delivery Table.*

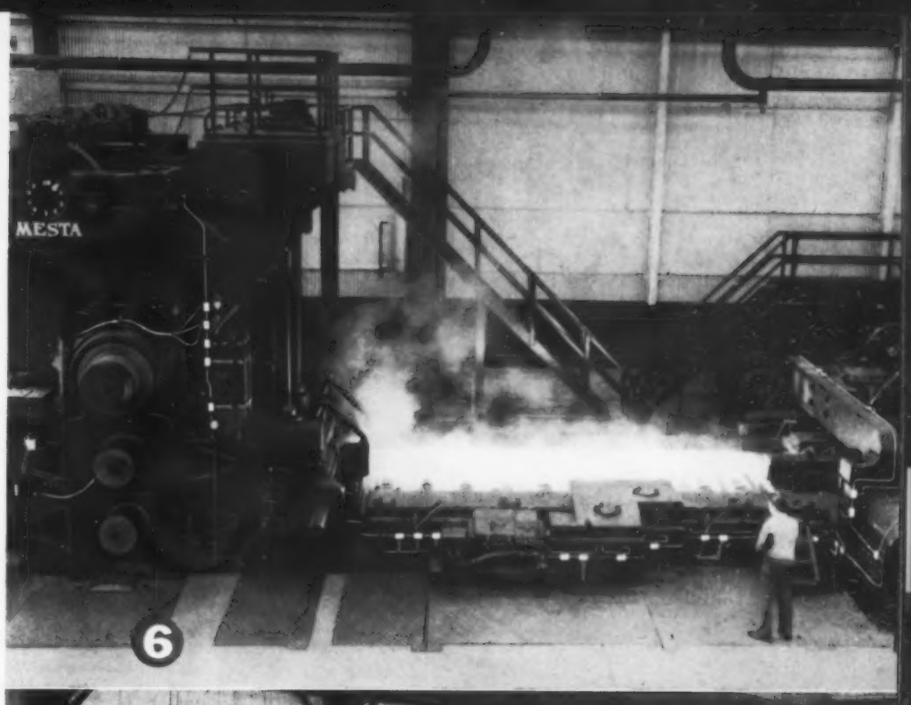
4. *Slab Pusher and Broadside Mill.*

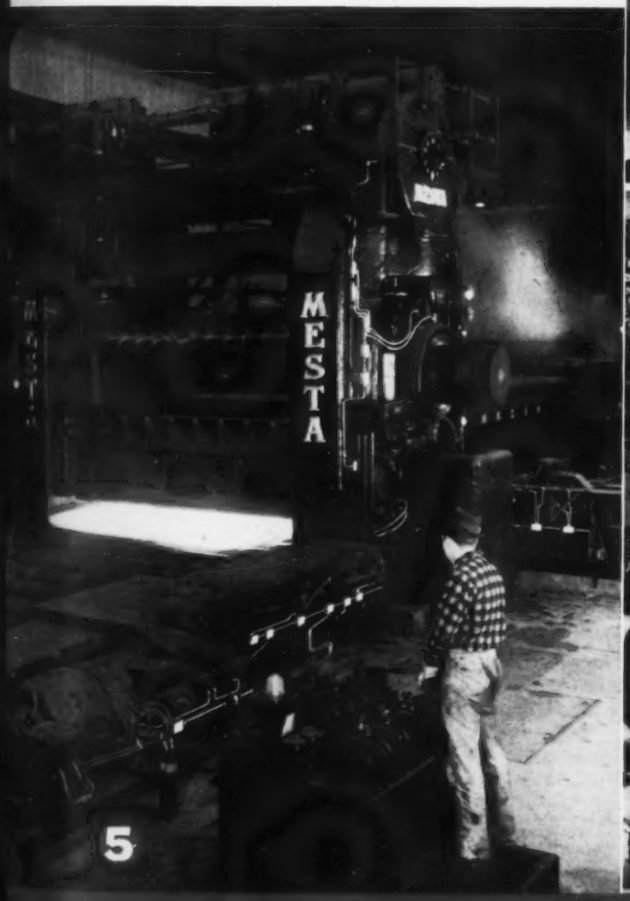
5. *Delivery Side of Broadside Mill.*

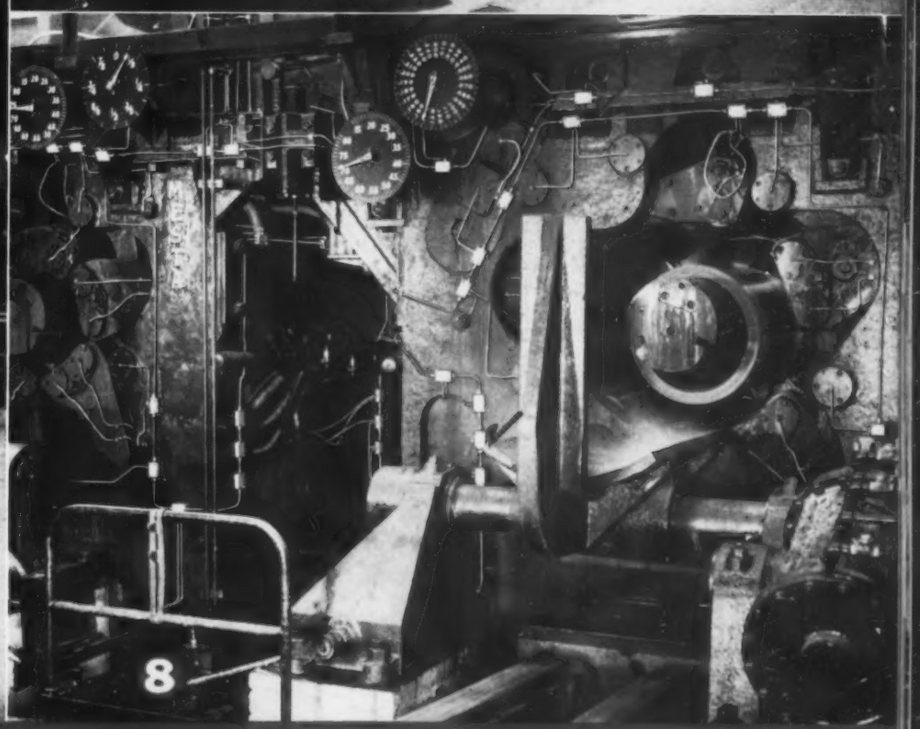
6. *Universal Roughing Mill and Slab Squeezer.*

7. *Finishing Train, Flying Shear, and Run-Out Table.*

8. *Hot Strip Coilers and Up-Enders.*

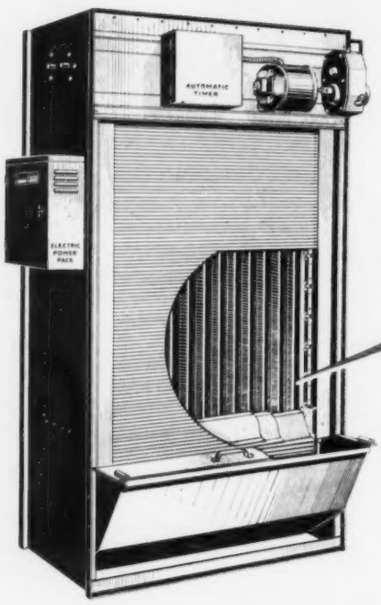






The Trabon Engineering Corp.

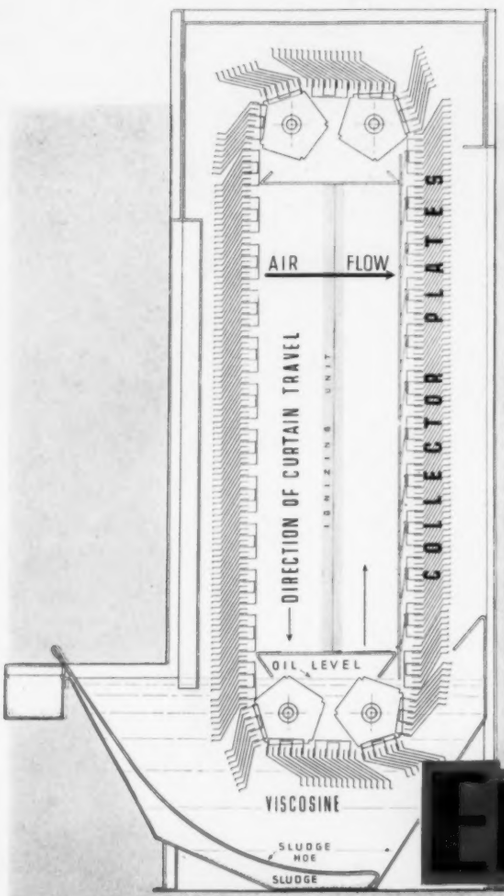
1814 East 40th Street **CLEVELAND, OHIO**



Now HARNESSED LIGHTNING CLEANS THE AIR!

The Electro-Matic

COMBINES ELECTRIC PRECIPITATION AS AN INTEGRAL PART OF AN AUTOMATIC AIR FILTER TO OBTAIN THE ULTIMATE IN HIGH EFFICIENCY AIR CLEANING.



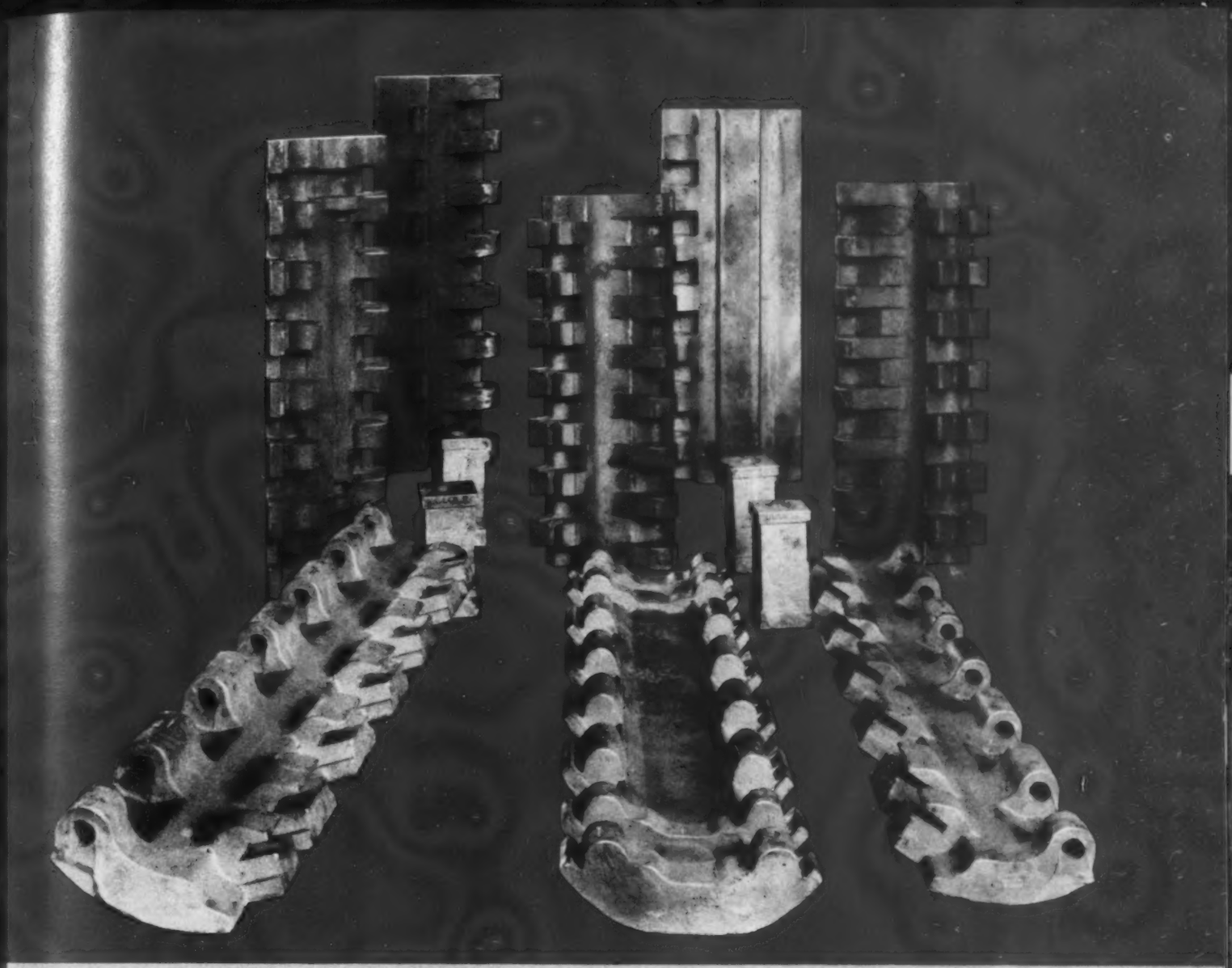
THE Electro-Matic filter is new only in that it successfully combines two widely used principles of cleaning air—*electric precipitation and viscous automatic air filtration*—to obtain the highest efficiencies in dust removal.

Electric precipitation has long been known as the most efficient method of collecting smoke and the finer dust particles; while the viscous automatic air filter with its self-cleaning and non-clogging features offers exclusive operating advantages.

The AAF Electro-Matic, incorporating these two tried and proven principles, makes possible the removal of dust over the complete range of particle sizes, approaching the ultimate in practical, high-efficiency air cleaning. Write for bulletin No. 250.

AMERICAN AIR FILTER CO., Inc.
534 Central Avenue Louisville, Kentucky
In Canada: Darling Bros., Ltd., Montreal, P. Q.

Electro-Matic
Automatic Self Cleaning Electric Precipitator



Swinging and Fixed Segments of D-H-S No. 2 Bronze. Weight 1100 to 1800 lbs. each.

D-H-S BRONZE

DUCTILITY · HARDNESS · STRENGTH

LONGER LIFE • LOWER COST

D-H-S No. 2 BRONZE

MINIMUM PHYSICAL PROPERTIES

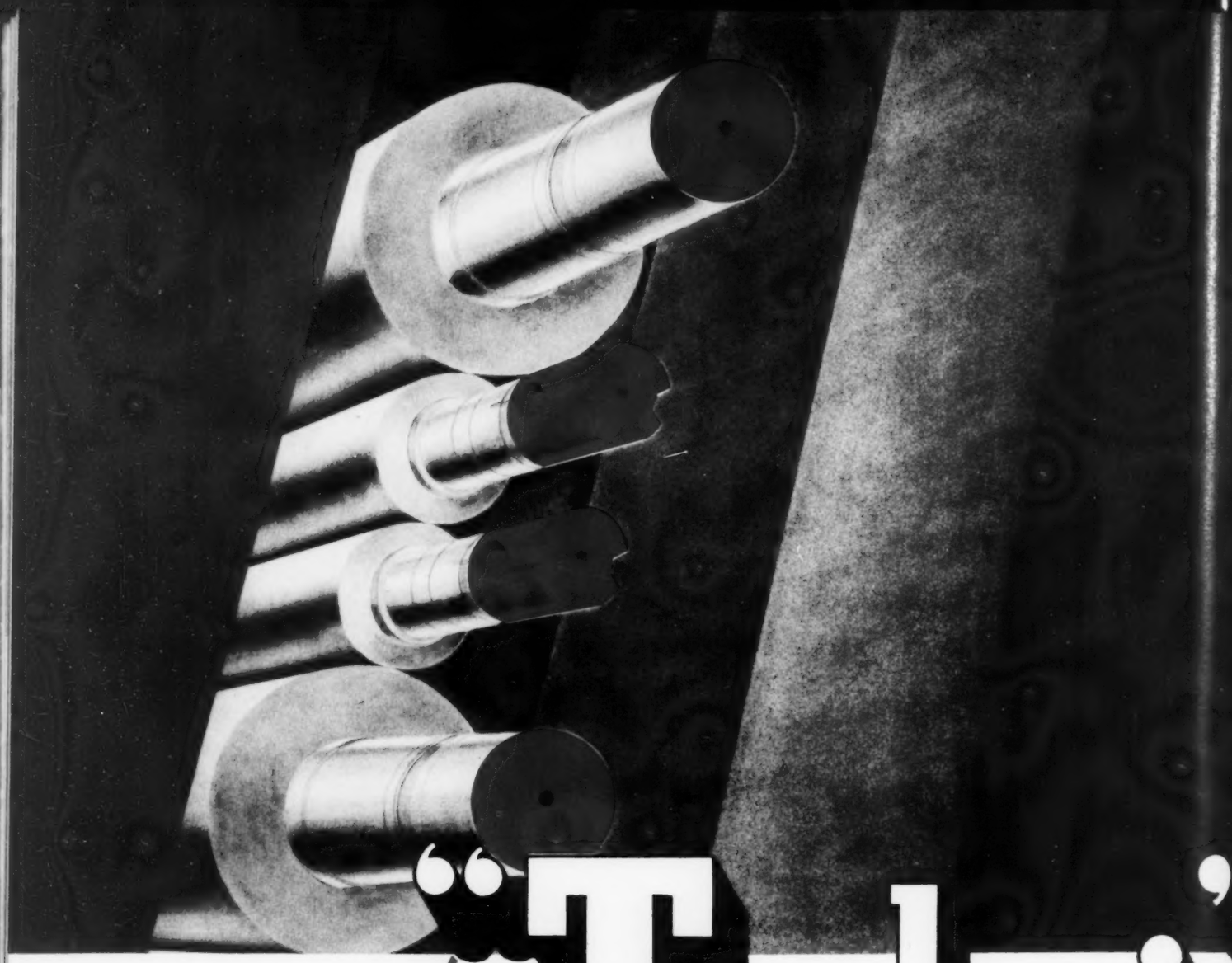
Ultimate Tensile Strength (lbs. per square inch)	115,000
Yield Point (lbs. per square inch)	90,000
Elastic Limit (lbs. per square inch)	55,000
Elongation—per cent in two inches	12
Reduction of Area—per cent	12
Brinell Hardness No.	225
Permanent Set under 100,000 lbs. per square inch	.020

Note: Recommended for applications where lineal contact speeds do not exceed 250 feet per minute.

Highest combination of balanced physical properties, found only in D-H-S Bronze. Superior for Reel Segments.

KOPPERS COMPANY · BARTLETT HAYWARD DIVISION · BALTIMORE, MARYLAND

a KOPPERS product



"Techni"

IRON ROLLS

STEEL ROLLS

The Techni Process Nichillite Rolls for No. 9 and No. 10 stands are the clear chill type of high nickel-bearing rolls which show great resistance to spalls and retain a fine surface that produces better finished strip.

Techni Process Nironite Rolls are high nickel-bearing rolls of the close condensed structure developed for intermediate stands. Nironite Rolls will not spall nor firecrack. They will help you cut costs and increase your production.

Technalloy Rolls, which are made by the Techni Process, have increased strength and greater hardness than similar compositions of ordinary steel base rolls; they are tougher, have denser grain structure, an ideal response to heat with minimum firecracking and produce exceptional tonnages per roll. They have established new records for steel base rolls. Technalloy Rolls are free from blow holes, streaks and spots of impurity segregation.

Irvin Works, Carnegie-Illinois Steel Corporation, is one of the many large plants using Techni Process Rolls.

PATENT APPLIED FOR

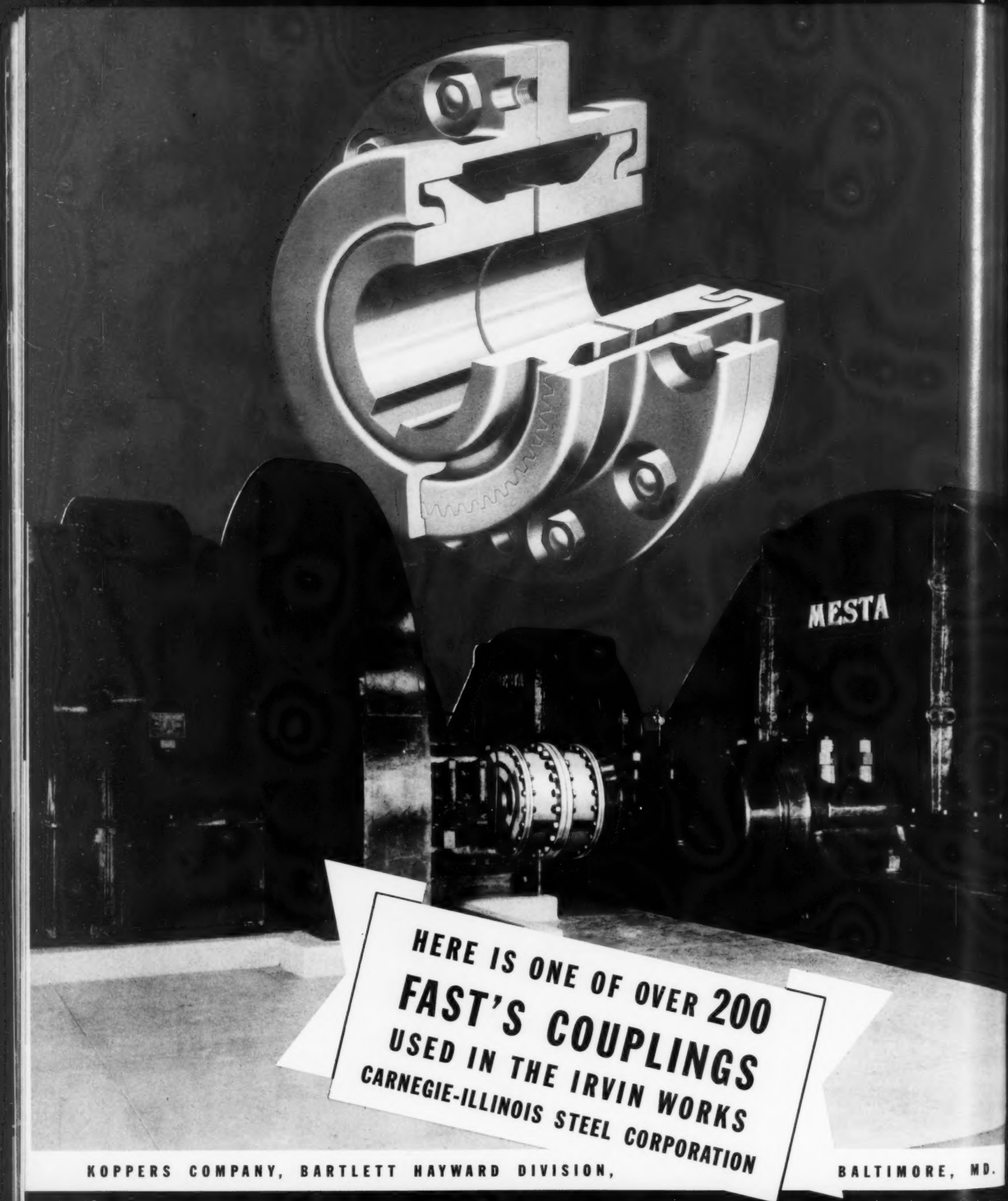
Rolls

for High Speed Continuous Strip Mills

The "Techni" Process rolls as applied to strip mill work have exceeded even our expectations. They have enabled keen, far-sighted mill men to produce strip of better finish and higher tonnages per grind than ever before.

The "Techni" Process is exclusive with Mackintosh-Hemphill Company.

MACKINTOSH-HEMPHILL CO., Pittsburgh and Midland, Pa.

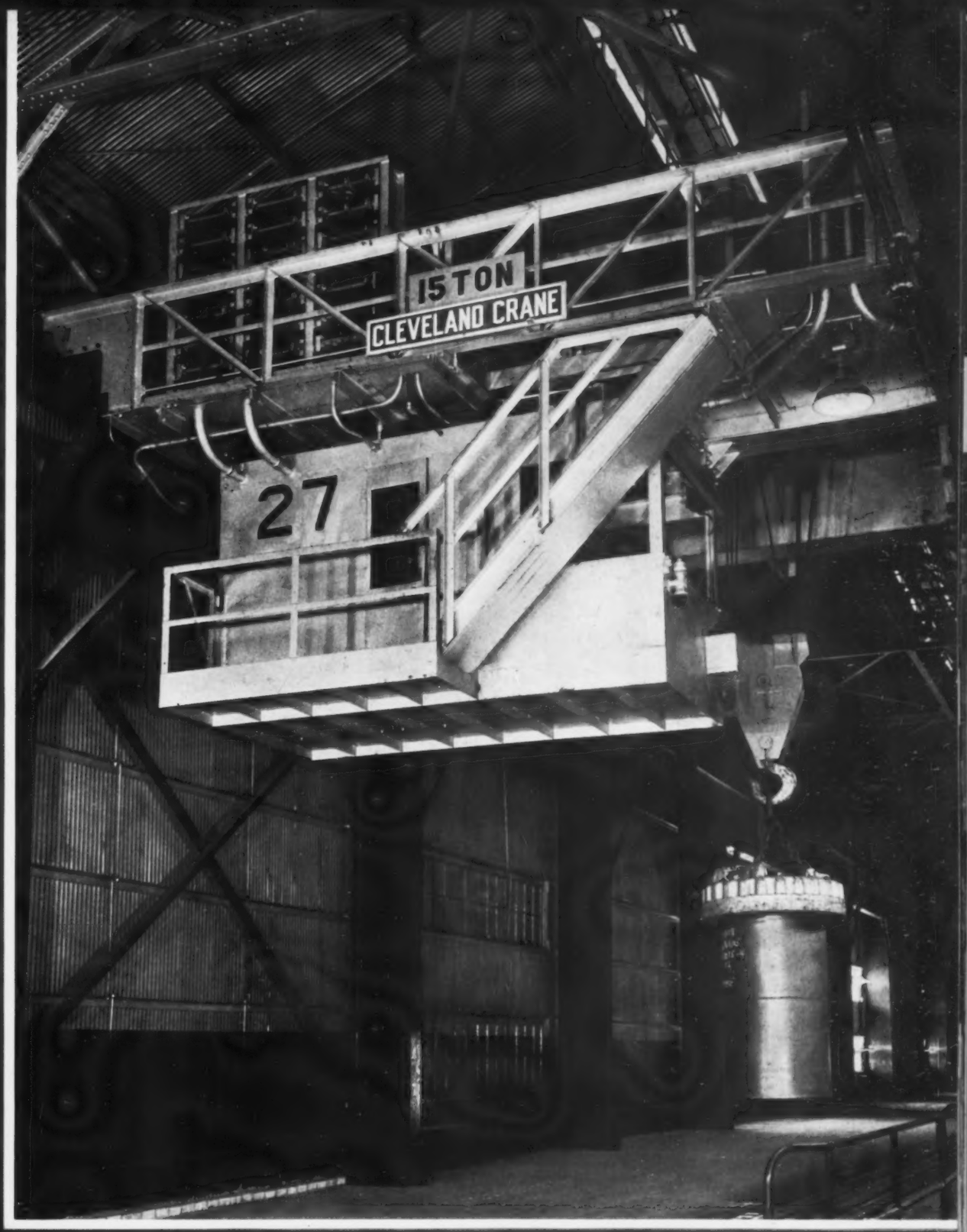


HERE IS ONE OF OVER 200
FAST'S COUPLINGS
USED IN THE IRVIN WORKS
CARNEGIE-ILLINOIS STEEL CORPORATION

KOPPERS COMPANY, BARTLETT HAYWARD DIVISION, BALTIMORE, MD.

FAST'S COUPLINGS

a KOPPERS product



CLEVELAND
CRANES
ALL WELDED

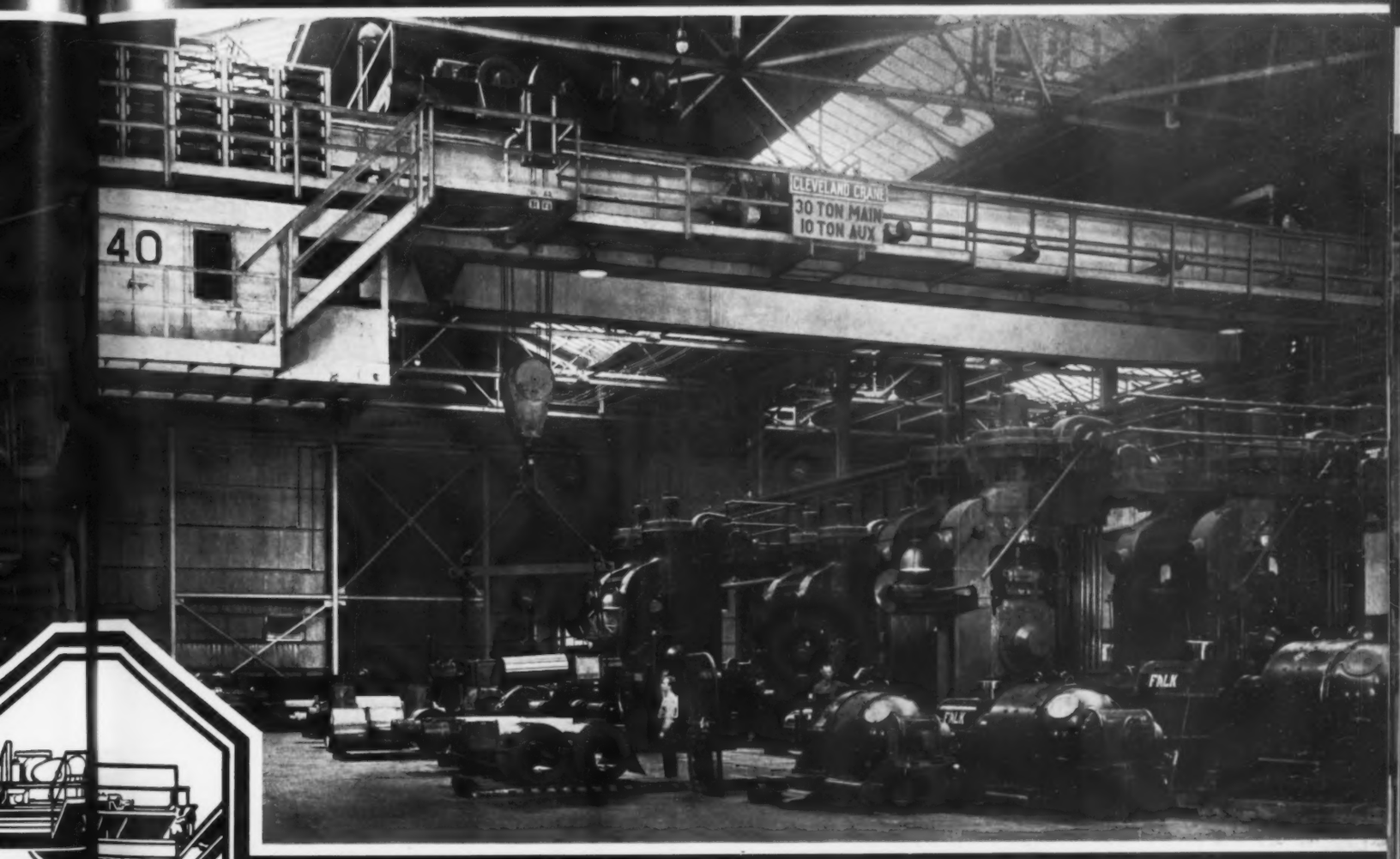
at the IRVIN

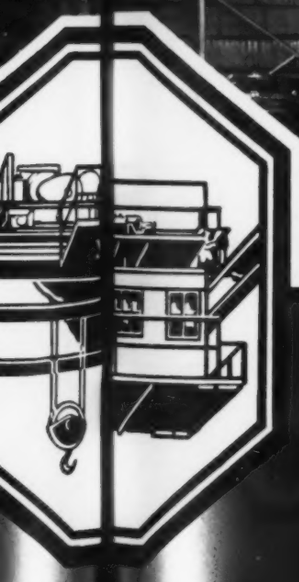
CLEVELAND

ALL WELDED

THE CLEVELAND CRANE
1131 DEPOT ST
NEW YORK DEPOT

WORKS





STEEL MILL CRANES

CRANE ENGINEERING CO.

DEPOT WICKLIFFE, OHIO

PITTSBURGH, CHICAGO

CLEVELAND ALL WELDED STEEL MILL CRANES

"CLEVELAND" APPLICATIONS IN STEEL

● Go where you will in any major Steel Plant, you always are near Cleveland Worm Gear Speed Reducers.

In the 20 years since the Industry installed its first "Cleveland," more than 225 different applications have been developed for modern steel plants, on the basis of "Clevelands'" inherent ability to withstand shocks and high peak loads.

Considering delivered horsepower and comparable design, you pay no more for Cleveland Worm Gear Drives—their stamina and endurance are your *extra* profit through long, unbroken years of service.

The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.

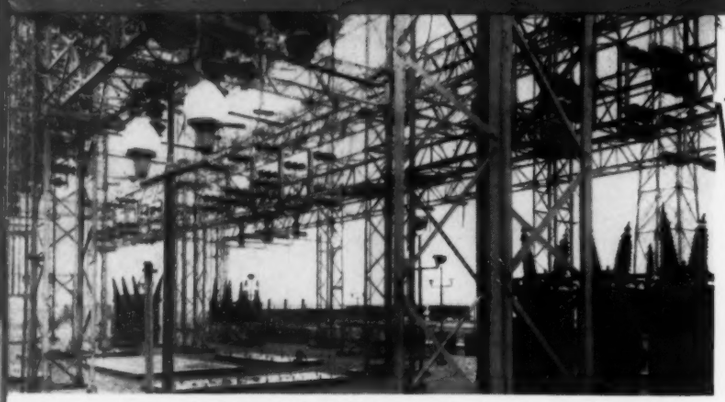
Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

IN CANADA: PEACOCK BROTHERS LIMITED

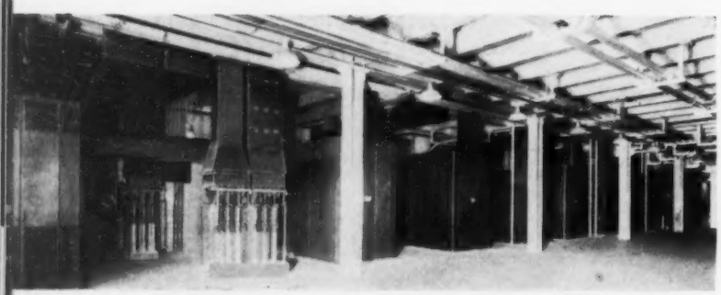
CLEVELAND *Worm Gear Drives*

The Story of

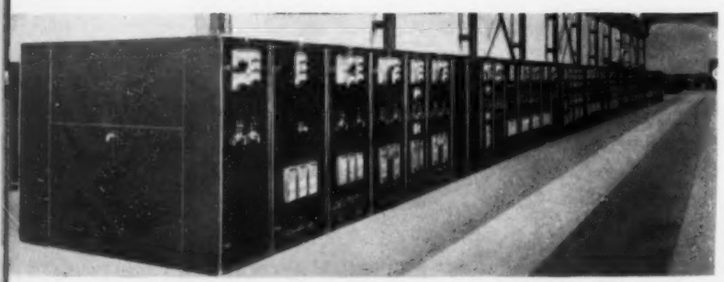
and a FAMOUS



Outdoor substation, with G-E 115,000-volt oil-blast circuit breakers, current and potential transformers, lightning arresters, and disconnecting switches



G-E factory-built synchronizing bus and reactor structure in basement of motor room. G-E factory-assembled, metal-enclosed bus connections pass through floor and directly into G-E metal-clad switchgear on floor above



G-E metal-clad switchgear, with oil-blast circuit breakers, provide 6600-volt distribution in motor room

G-E 600-volt d-c switchgear, with air circuit breakers, in basement at finishing end of motor room. Note heavily constructed bus and cross-overs

SOME OF THE G-E EQUIPMENT INSTALLED IN THIS PLANT:

27,000 hp of main-roll drives for the finishing stands of the 80-inch hot-strip mill

21,000 kw of motor-generator sets for the finishing-stand motors

115,000-volt switching equipment in the outdoor substation

The factory-assembled, metal-enclosed bus that brings 6600-volt power from the substation to the motor room

All 6600-volt switchgear for the main substation, the hot-strip mill, and river pump house

All 600-volt d-c switchgear for the main-roll drives

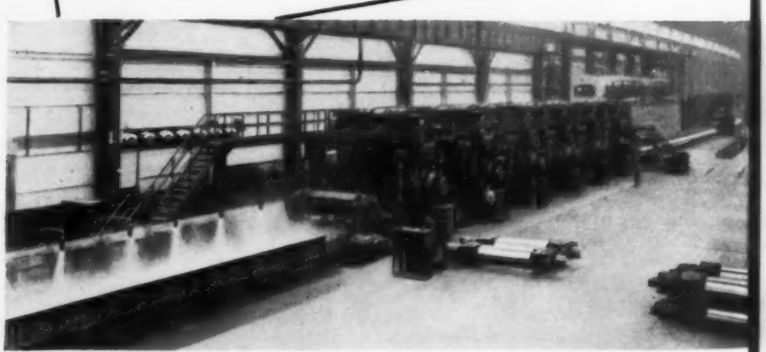
All auxiliary motors for the hot-strip mill, including the drives for the screwdowns, d-c runout-tables, coilers, and flying shear

Factory-assembled control for all main-roll drives

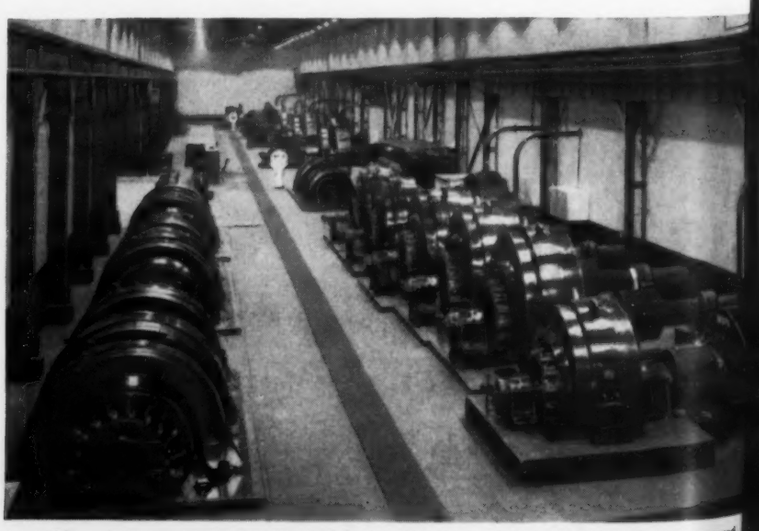
Factory-assembled control for all auxiliary drives

Motors and control for nine shearing lines

Motors, motor-generator set, and control for the record-breaking, 5-stand, tin-plate mill



The 80-inch hot-strip mill, showing the finishing stands driven by G-E motors



View of motor room from finishing end, showing 27,000 hp of G-E d-c finishing-mill motors powered by three G-E 7000-kw motor-generator sets

General Electric

NEW STEEL PLANT

THE Irvin Works of the Carnegie-Illinois Steel Corporation, located in the Pittsburgh area, is known throughout the steel industry for its size, the power and speed of its mills, its economy of operations, and the excellence of its products.

The part that General Electric played in equipping this plant is partially illustrated and described on these pages.

It is a story of detailed planning from the ground up before any of the equipment was built, of continual co-operation between G-E engineers and the steel company, the mill builders, and the machinery manufacturers.

It is a story of how a great quantity and wide variety of G-E equipment was designed, applied, and co-ordinated, of how G-E engineers helped turn the ideas and suggestions of the steel-mill engineers and operators into actual achievement.

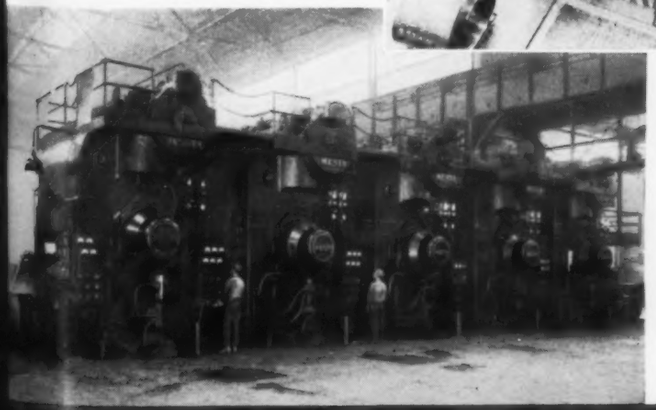
It is a story of how extensive assembling of equipment at the factory made possible great savings in installation time and expense, of how metal enclosure of such equipment as the main power bus, switchgear, and control has contributed to increased safety of operations.

And it is a story of excellent performance—performance that again shows the ability of General Electric to meet the many electrical requirements of the steel industry in its progress toward faster, more economical steel rolling. General Electric, Schenectady, New York.

G-E factory-assembled control (at left) and G-E motor-generator sets used in adjustable-voltage control of d-c runout-table, coiler, and flying shear motors. G-E 440-volt a-c power distribution board (rear right)

Some of the 200 G-E d-c motors, employing adjustable-voltage control, driving runout-table in the 80-inch hot-strip mill

One of the nine shearing lines equipped with G-E motors and control



The five-stand, tandem, cold-strip mill that has set a record for tin-plate production. This mill is equipped with G-E motors, motor-generator set, and control

SOME G-E ENGINEERING CONTRIBUTIONS:

Complete station-layout drawings for the hot-strip-mill motor room

Design of the intricate bus structure to withstand severe short circuit stresses which might occur because of the enormous concentration of power

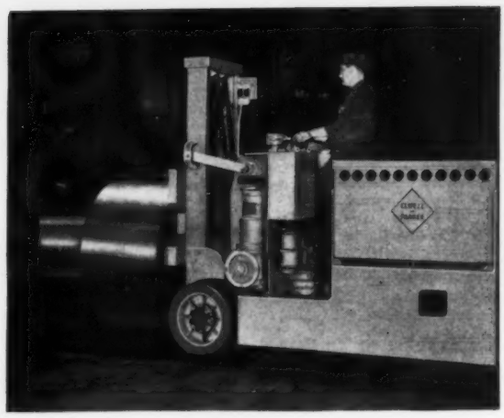
Design of new devices and systems of control to meet special operating problems

The system of recirculating ventilation for the motor room that keeps the room at a desirable operating temperature despite the heat produced by the rotating equipment

Special control for the five-stand cold-strip mill which has enabled the operators to set new records for tin-plate production

GENERAL ELECTRIC

TINPLATE RIDES ELWELL-PARKERS all the way from Cold Mill to Boxcar and—*Handling Costs Drop!*



FROM coilers to shears, warehouse, sorting room, boxcar—and again between processes at the container manufacturer's plant—

Tinplate travels on Elwell-Parker Power Industrial Trucks in a controlled production flow that keeps the sheets moving evenly—*and holds transportation costs down.*

Modern, capable Elwell-Parkers are engaged in steel-handling operations similar to these, in the Pittsburgh District's newest Mill. A greatly-expanded plant under the same ownership elsewhere, has bought Elwell-Parkers for 25 years.

Elwell-Parker Trucks, Tractors and Cranes are geared to the Industry's critical demands. Elwell-Parker Steel Plant Specialists will co-operate capably in planning and supplying the Truck Equipment that will save most money on *your* steel-handling operations.

Write or wire today. The Elwell-Parker Electric Co., 4504 St. Clair Avenue, Cleveland, Ohio.

ELWELL-PARKER *Power Industrial* **TRUCKS**

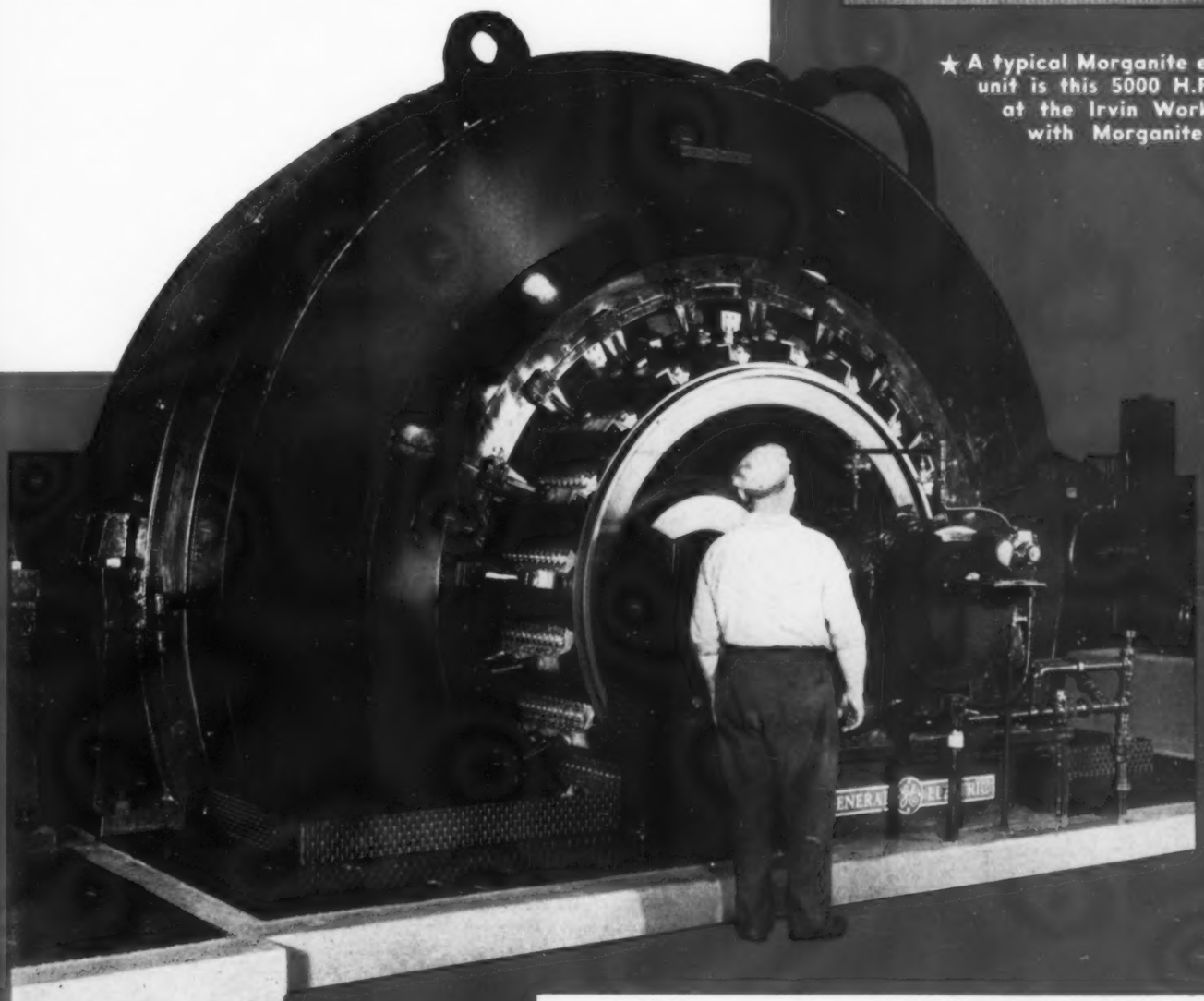
ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

Look!

LOOK . . . as carefully as you please at the Morganite brushes in service at the Irvin and Edgar Thomson Works of Carnegie-Illinois Steel Corporation.

MORGANITE BRUSH CO., INC.
LONG ISLAND CITY, N. Y.

★ A typical Morganite equipped unit is this 5000 H.P. motor at the Irvin Works fitted with Morganite EG/14.



MORGANITE
AT BOOTH 109

368 "TOOL STEEL"

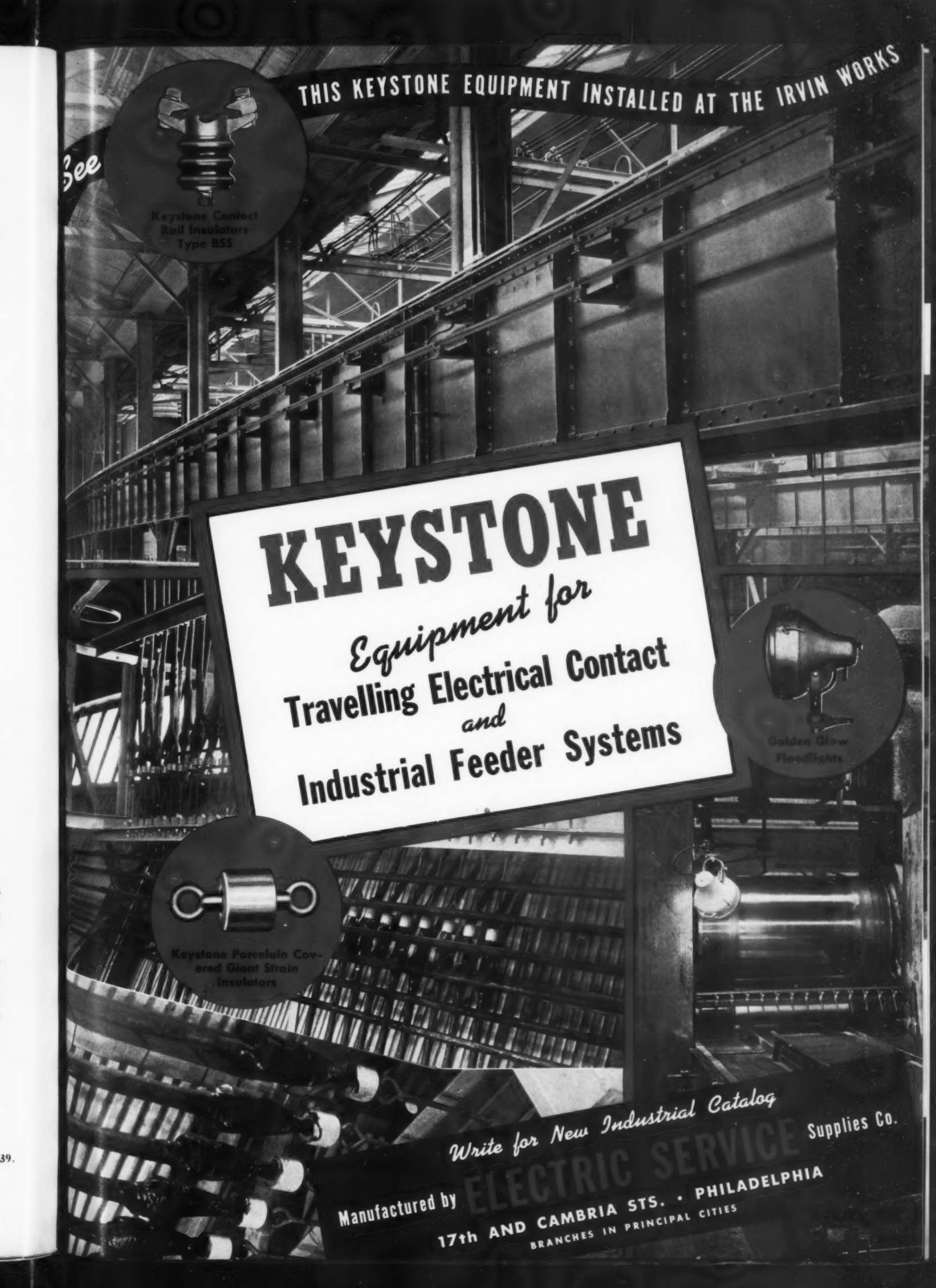
LEVELLERS, COILERS AND PINCH ROLLS SPECIFIED IN NEW MILL

"Tool Steel" Rolls have been Specified by the builders of all of the new strip mills in the country because of their proven superiority.

Starting a new mill with rolls of maximum hardness and strength means a much longer period before replacements are made and in the meantime a more perfect product.

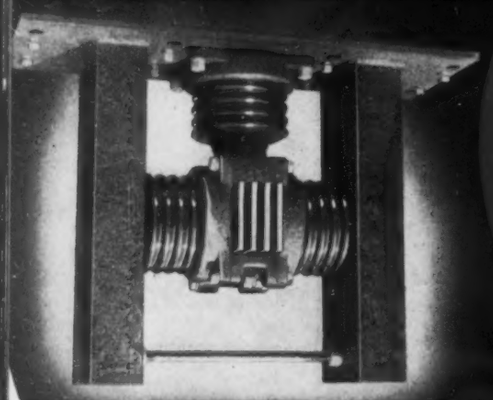
THE TOOL STEEL GEAR & PINION CO.

CINCINNATI, OHIO

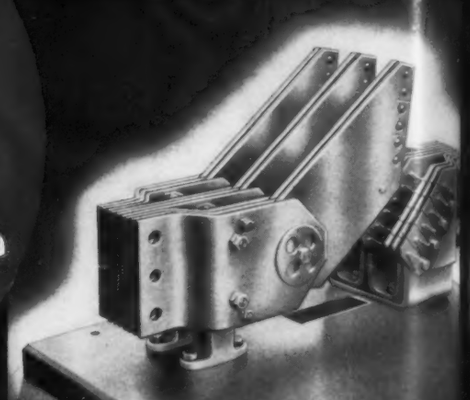

THIS KEYSTONE EQUIPMENT INSTALLED AT THE IRVIN WORKS
Keystone Contact Rail Insulators Type BSS
KEYSTONE
Equipment for
Travelling Electrical Contact
and
Industrial Feeder Systems
Golden Glow Floodlights
Keystone Porcelain Covered Giant Strain Insulators
Write for New Industrial Catalog
Manufactured by ELECTRIC SERVICE Supplies Co.
17th AND CAMBRIA STS. • PHILADELPHIA
BRANCHES IN PRINCIPAL CITIES

R&IE

"covers the steelfront"

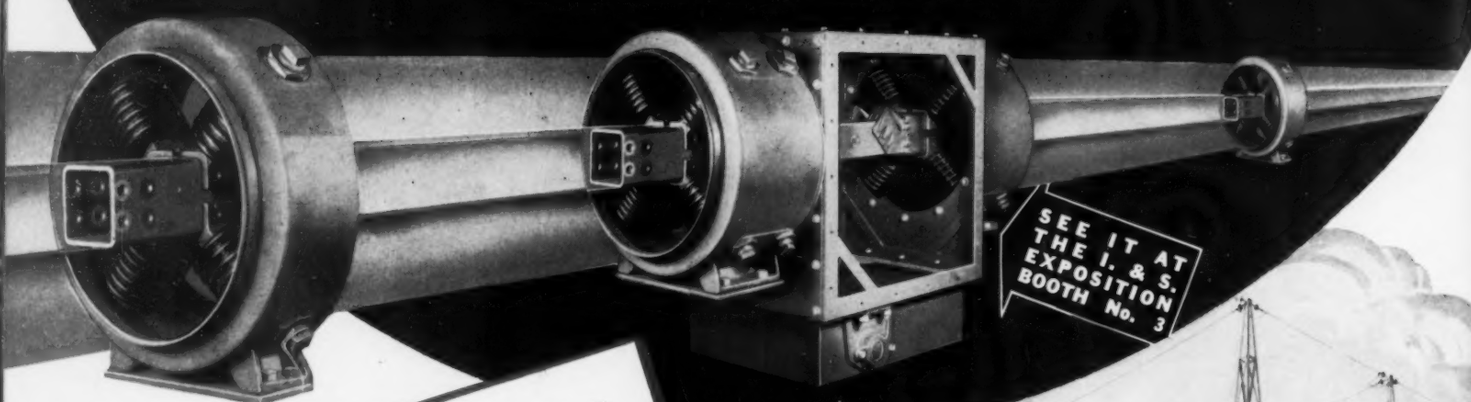


CONDUCTOR SUPPORTS



HEAVY DUTY DISCONNECTS

ENCLOSED SWITCH *and* BUS

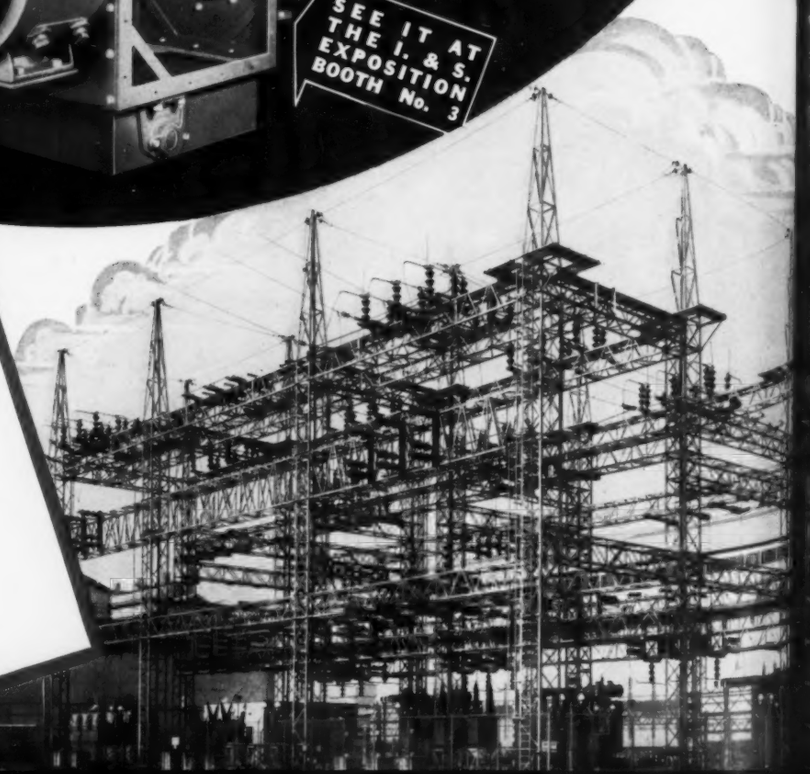


SEE IT AT THE I. & S. EXPOSITION BOOTH No. 3

R.&I.E.
salutes the new
IRVIN WORKS
of the
CARNEGIE-ILLINOIS STEEL CORP.

•

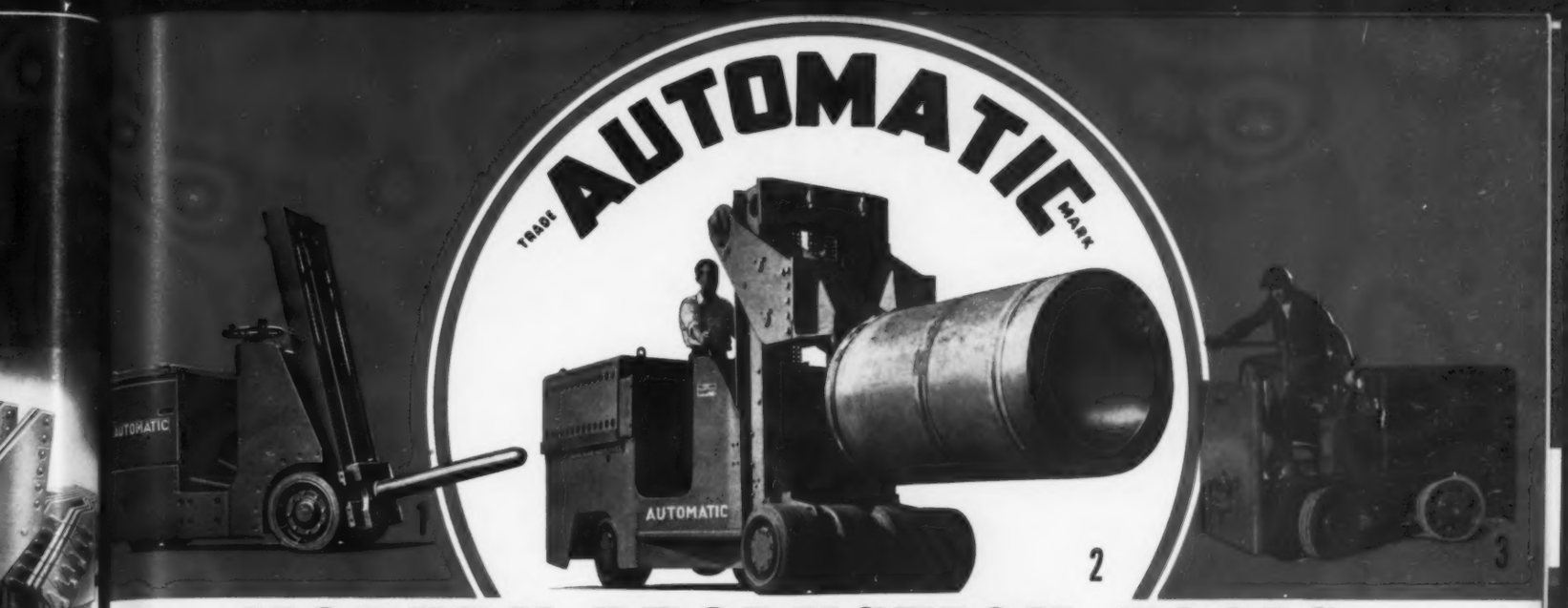
Through the substation shown at the right flows all the electrical energy to operate this modern mill. Designed and erected by R. & I. E.—it is another example of effective service to the Steel Industry.



R. & I. E. has kept pace with the changing demands of the steel industry. See the latest transmission equipment at the Iron and Steel Exposition——then consult R. & I. E. with your next problem.

RAILWAY AND INDUSTRIAL ENGINEERING CO., GREENSBURG, PA.

IN CANADA — Eastern Power Devices, Ltd., Toronto



MODERN PRODUCTION TOOLS

CONTRIBUTING IMPORTANT ECONOMIES TO THE *Iron and Steel Industry*

Here are illustrated some of "AUTOMATIC'S" TIME-PROVEN PRODUCTION TOOLS, which today are vital factors twenty-four hours, day in day out, contributing successful, dependable, economical, profitable coil and sheet handling, transportation and stacking in many modern Steel Mills in United States, Canada and Foreign Countries.

The Roster* of "AUTOMATIC'S" fleet and unit installations in the Steel Industry reads like the Blue Book of American Industry.

That's only natural! "AUTOMATIC" earned this leadership. For, over three years ago "AUTOMATIC" anticipated modern production requirements, which became apparent for new flexible transportation facilities with speed, precision, safety and efficiency regardless of load.

The Result! "AUTOMATIC" was prepared years ahead with a complete line of coil and sheet handlers developed in every capacity to serve this growing demand. These "AUTOMATICS" have been imitated but never duplicated. So when you buy Coil or Sheet Handlers Don't buy automatically! Buy "AUTOMATIC."

Perhaps one of these "AUTOMATICS" shown are just the type you need right now! Write or 'phone today for full details and prices without obligation.

**Names on request.*

1. Center Control Ram Trucks—4,000 and 6,000 lbs. capacity.
2. Super-Duty Ram Trucks for widest welded coils capacities up to 30,000 lbs.
3. Heavy-Duty Tractors Two and Four Wheel Drive capacities up to 6,000 lbs.
4. Heavy-Duty Coil Handlers capacities up to 18,000 lbs.
5. Center-Control Tiering Bosh Tank Trucks.
6. Heavy-Duty Cranes—MOTORIZED Slewing capacities up to 15,000 lbs.
7. Center-Control Fork Trucks—7,000 to 18,000 lbs. capacity.
8. Center-Control Fork Trucks—3,000 to 6,000 lb. capacities TELESCOPIC and NON-TELESCOPIC.

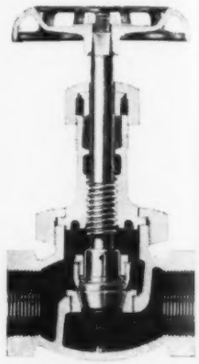
AUTOMATIC TRANSPORTATION CO.
DIV. OF THE Y. & T. MFG. CO.
47 W. 87th St. CHICAGO, ILL.

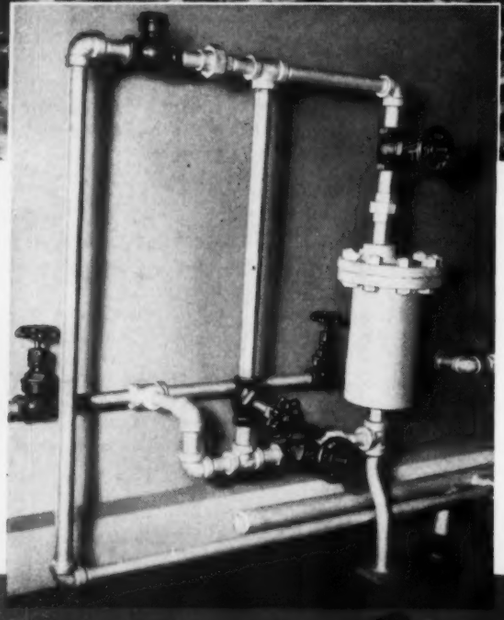
See the "AUTOMATIC" Display at Pittsburgh IRON and STEEL SHOW
SEPTEMBER 26-29th—BOOTHS B-5 and 86

JENKINS ARMOR-SEAT VALVES
for Tough Services

LOOK FOR THEM AT IRVIN WORKS

✸ **This Jenkins Armor Seat Valve for 300 lb. steam pressure has a plug and seat ring . . . of Jenkins JX500 special Alloy Steel, HARDER THAN 500 BRINELL.**





AT LEFT you see one of the typical tough-duty services in which Jenkins Fig. 976 Plug Seat Regrinding Globe Valves are installed in the Irvin Works of Carnegie Illinois Steel Corporation.

These Valves control the temperature of the palm oil (used in polishing the tinplate) and are operated under throttled conditions continuously—the most severe service to which a valve can be subjected.

Other standard Jenkins Valves shown in the photo and used throughout the plant include:—*Extra Heavy Pattern*:—Bevel Seat Bronze Globe Valves, Bronze Check Valves, Bronze Gate Valves: *Standard Pattern:*—Bronze Check Valves and Bronze Gate Valves—all in the one inch sizes.

JENKINS BROS., 80 White Street, New York, N.Y.; Bridgeport, Conn.; Boston, Mass.; Chicago Ill.; Philadelphia, Pa.; Atlanta, Ga.; Houston, Texas Montreal, Canada London, England

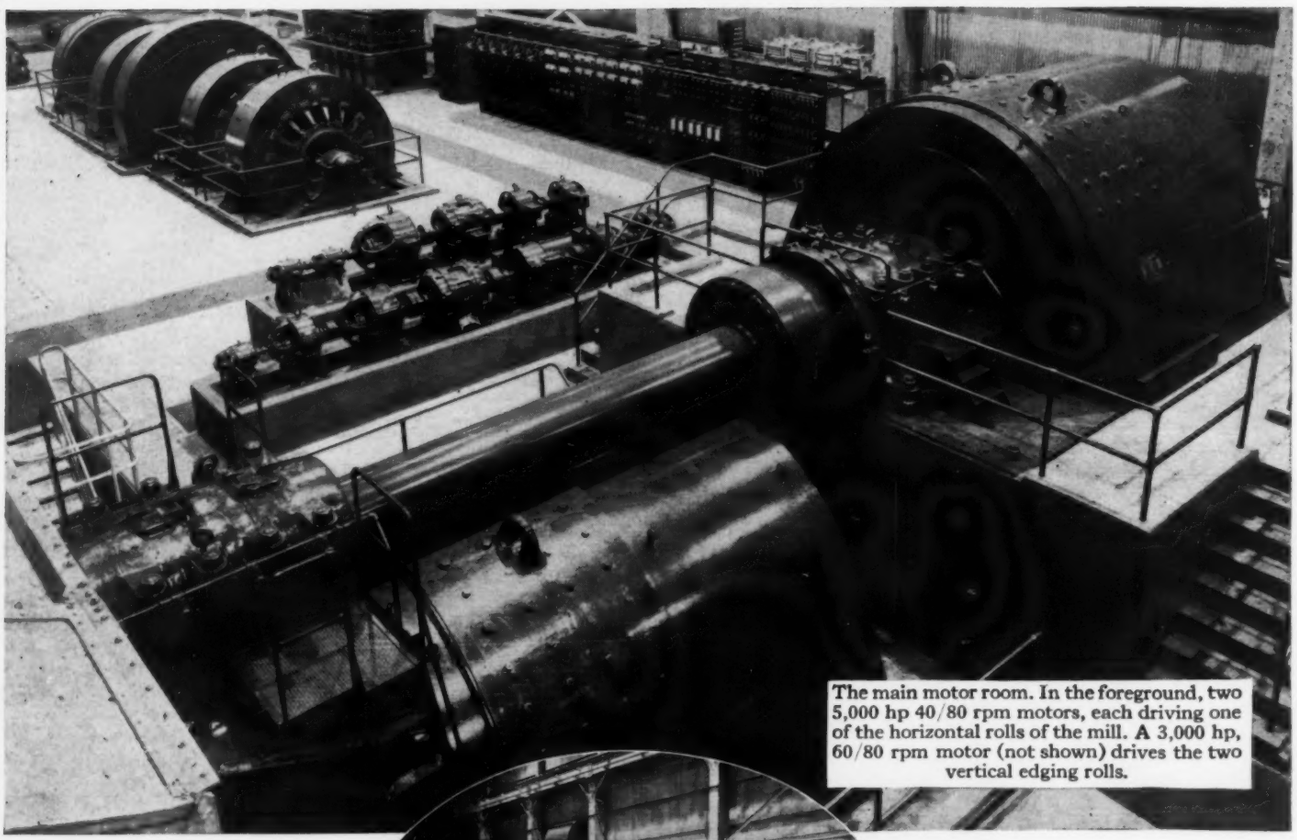
IN VALVES *Jenkins* GIVES YOU EVERYTHING

Sixteen of these Swindell-Dressler radiant tube annealing covers are assisting the operating personnel to reach and maintain the high standards of quality insisted upon at the Irvin Works of Carnegie-Illinois Steel Corporation. They are heated by coke oven gas in horizontal recirculating radiators.

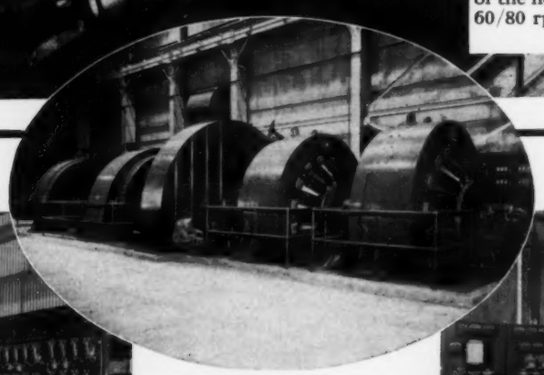
SWINDELL-DRESSLER CORPORATION

PITTSBURGH, PA.

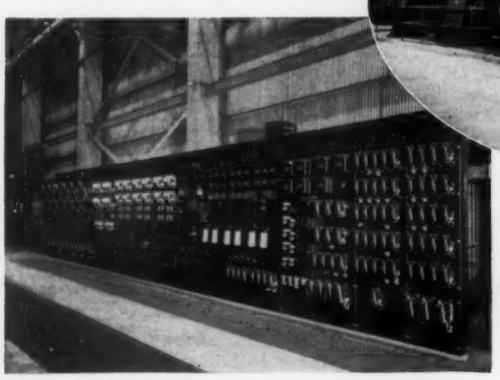
☆ 13,000 H.P. on



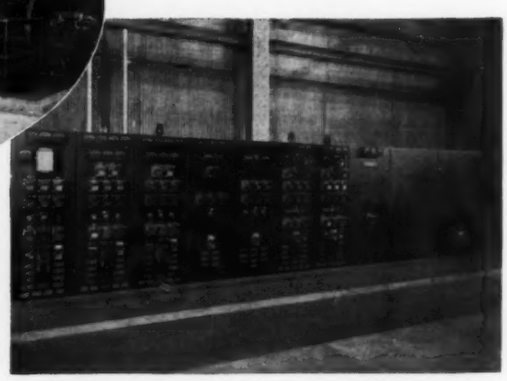
The main motor room. In the foreground, two 5,000 hp 40/80 rpm motors, each driving one of the horizontal rolls of the mill. A 3,000 hp, 60/80 rpm motor (not shown) drives the two vertical edging rolls.



The 10,500 kw flywheel motor generator set, supplying variable voltage power at 700 volts to the main mill motors.



The main 700-volt d-c control board, controlling operation of the generators and main drive motors.



Metal-clad switchgear equipment controlling the 6,600 volt circuits to motor generator sets and transformers.

Westinghouse

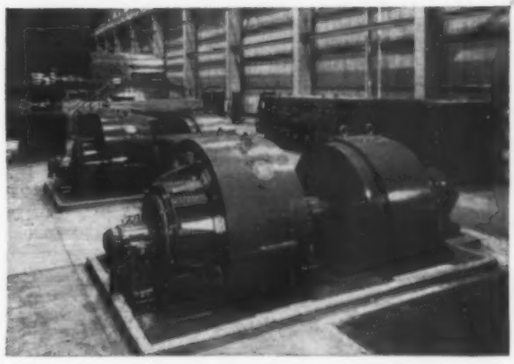
W
WESTINGHOUSE ELECTRIC

a Single Stand!

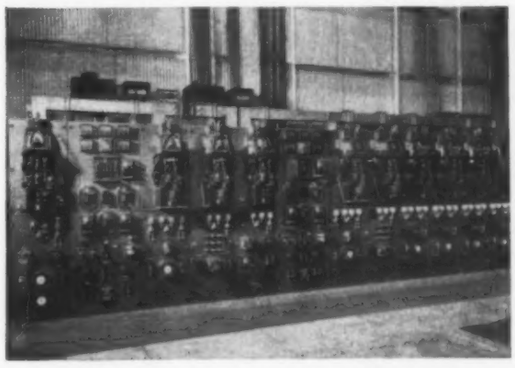
With 10,000 hp on the horizontal rolls and 3,000 hp on the vertical rolls, this installation of Westinghouse equipment on the slabbing mill at the Edgar Thomson Works of Carnegie-Illinois Steel Corp. is the largest amount of power so far applied to a single mill stand.

When the steel industry considers heavy mill equipment, particularly of the slabbing or blooming mill type, it is only natural that they should turn to Westinghouse for main and auxiliary drives.

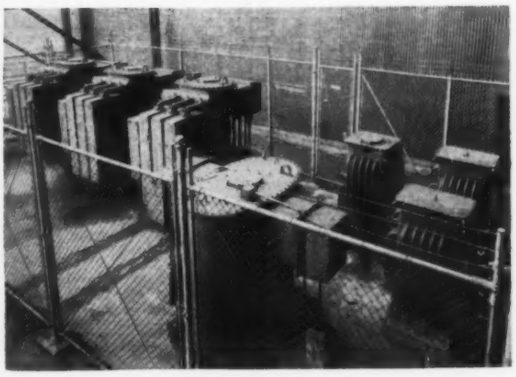
WESTINGHOUSE ELECTRIC & MANUFACTURING CO.,
EAST PITTSBURGH, PA.



Motor generator sets, each 1,500 kw, furnishing 250 volt d-c power for the mill auxiliary motors.

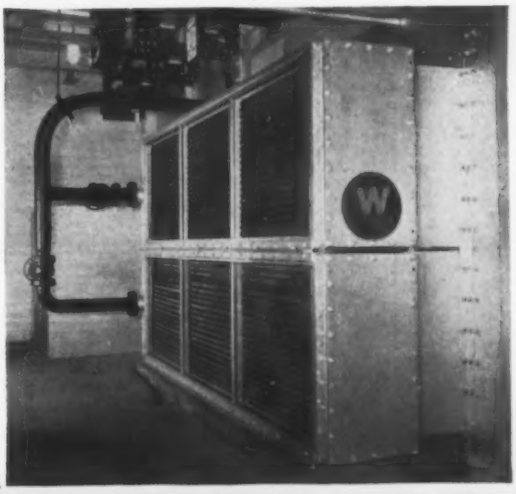


The 250 volt d-c auxiliary power distribution switchboard.



Outdoor substation and transformers to step down 6,600 volt power for auxiliary motors and lights.

A section of the air coolers that supply 130,000 cubic feet of air per minute to cool the reversing mill motors.

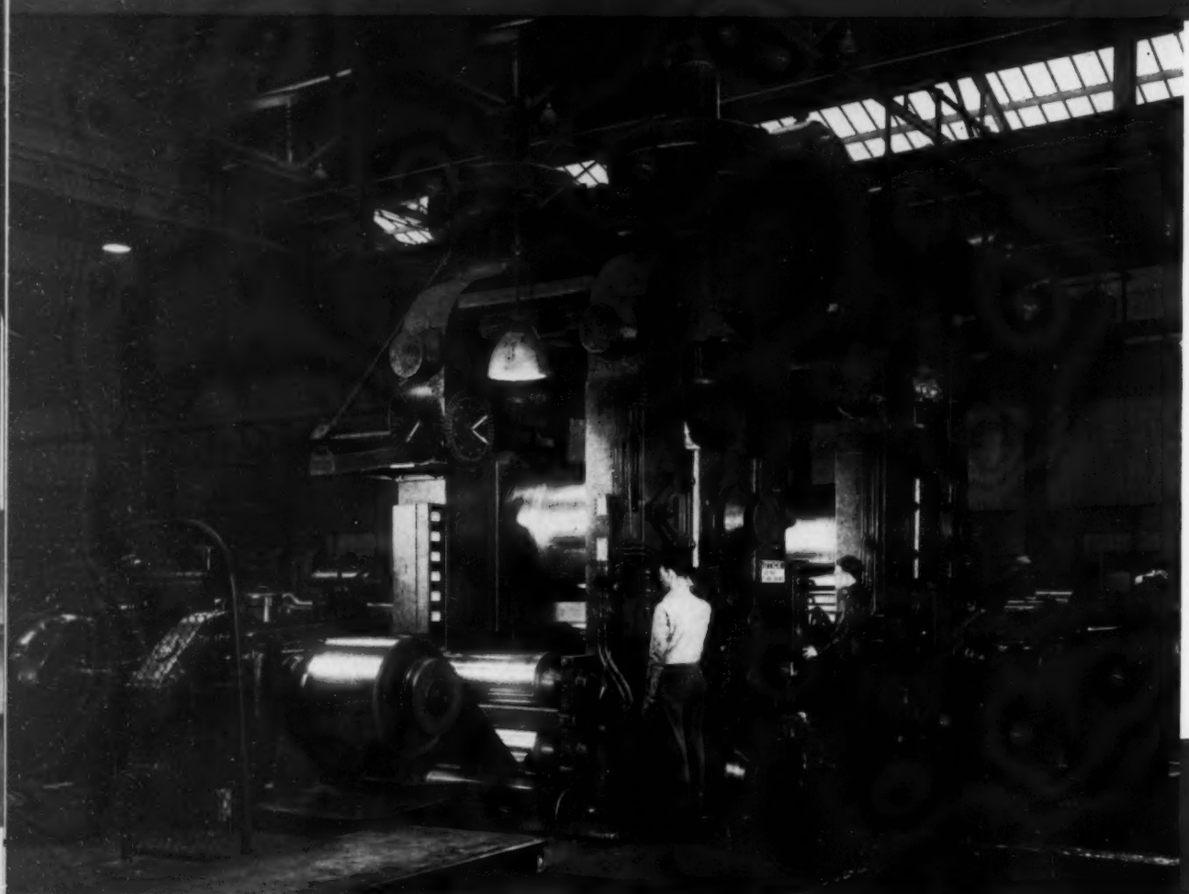


J-94154

ELECTRICAL PARTNER OF THE STEEL INDUSTRY

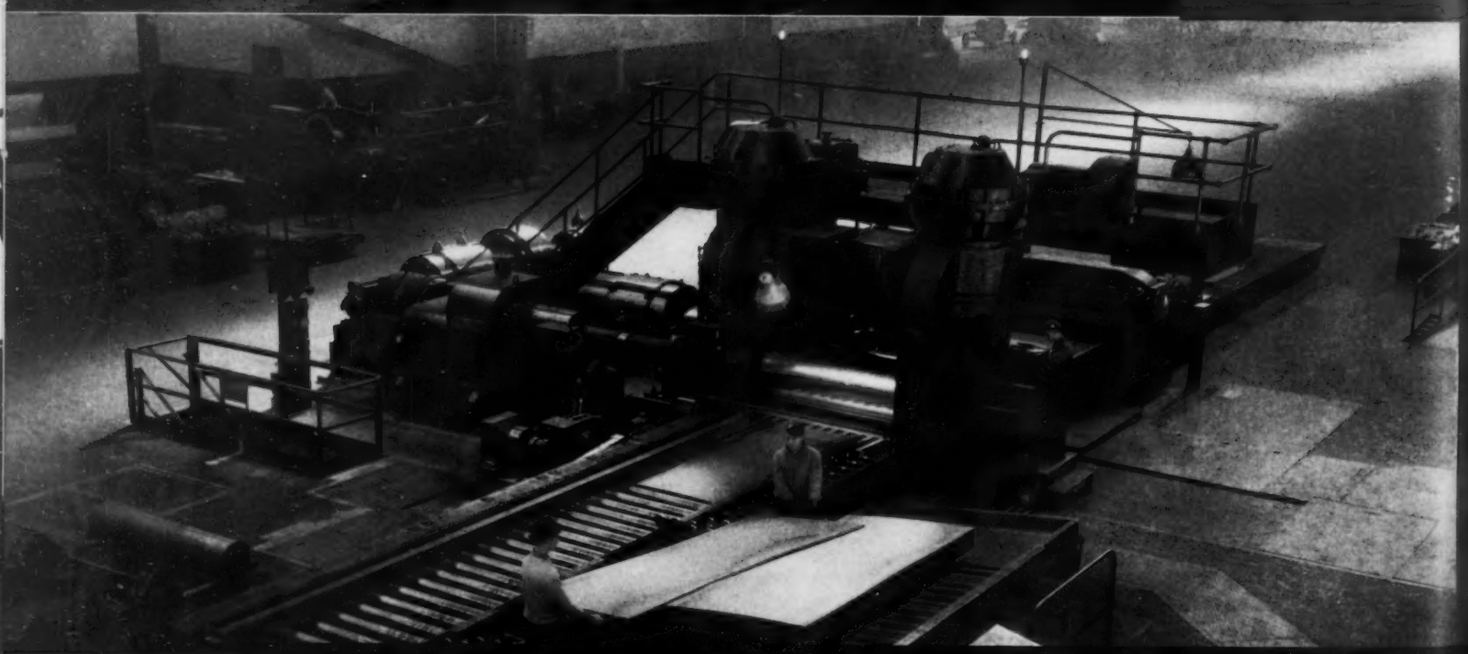
MORE THAN 80 YEARS

Built into these BLISS MILLS



42-Inch Two-Stand Four High Tin Temper Mill —General View From Delivery End.

84-Inch Two High Temper Mill for Sheets and Coils—Entry End.



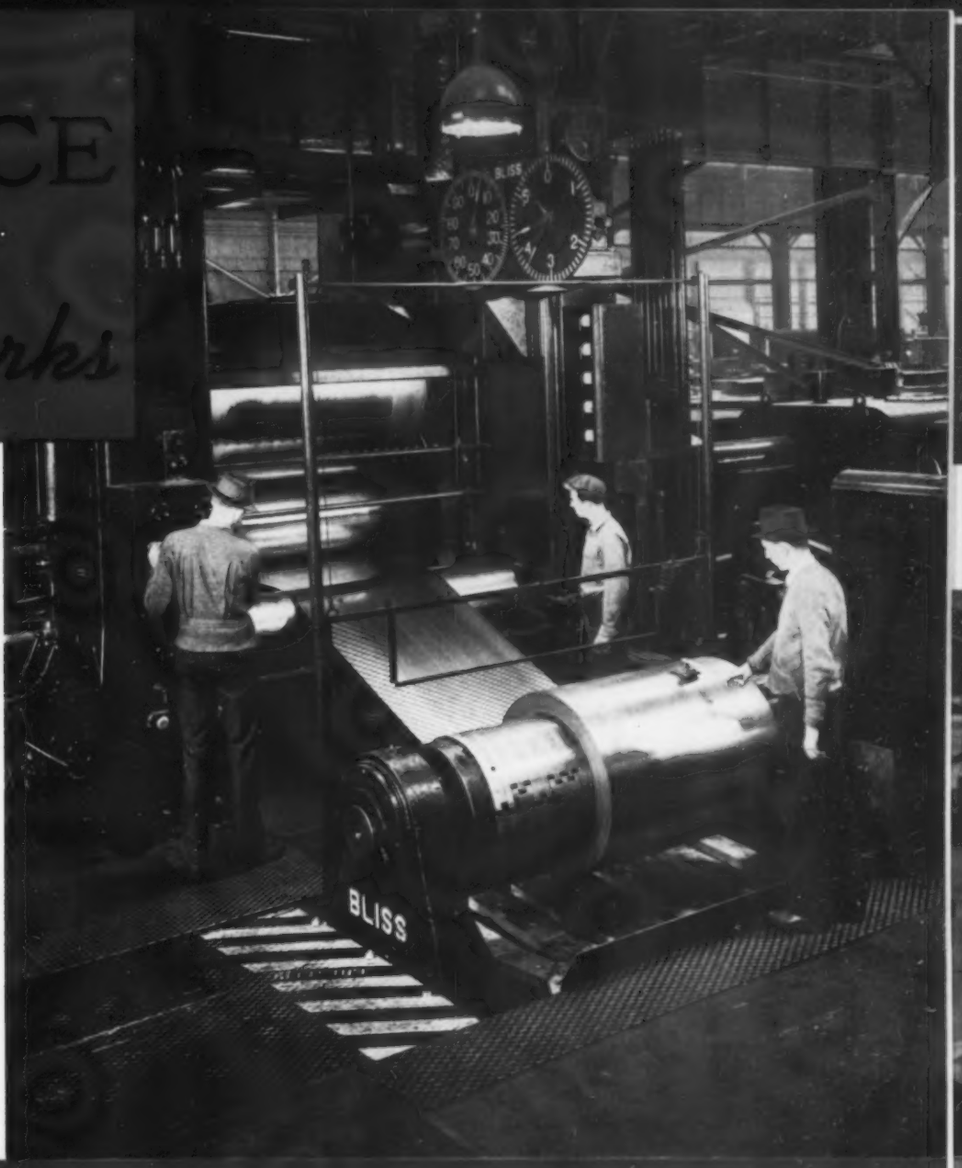
E.W.BLISS Co. CONSULTANTS - DESIGNERS - BUILDERS

RS EXPERIENCE

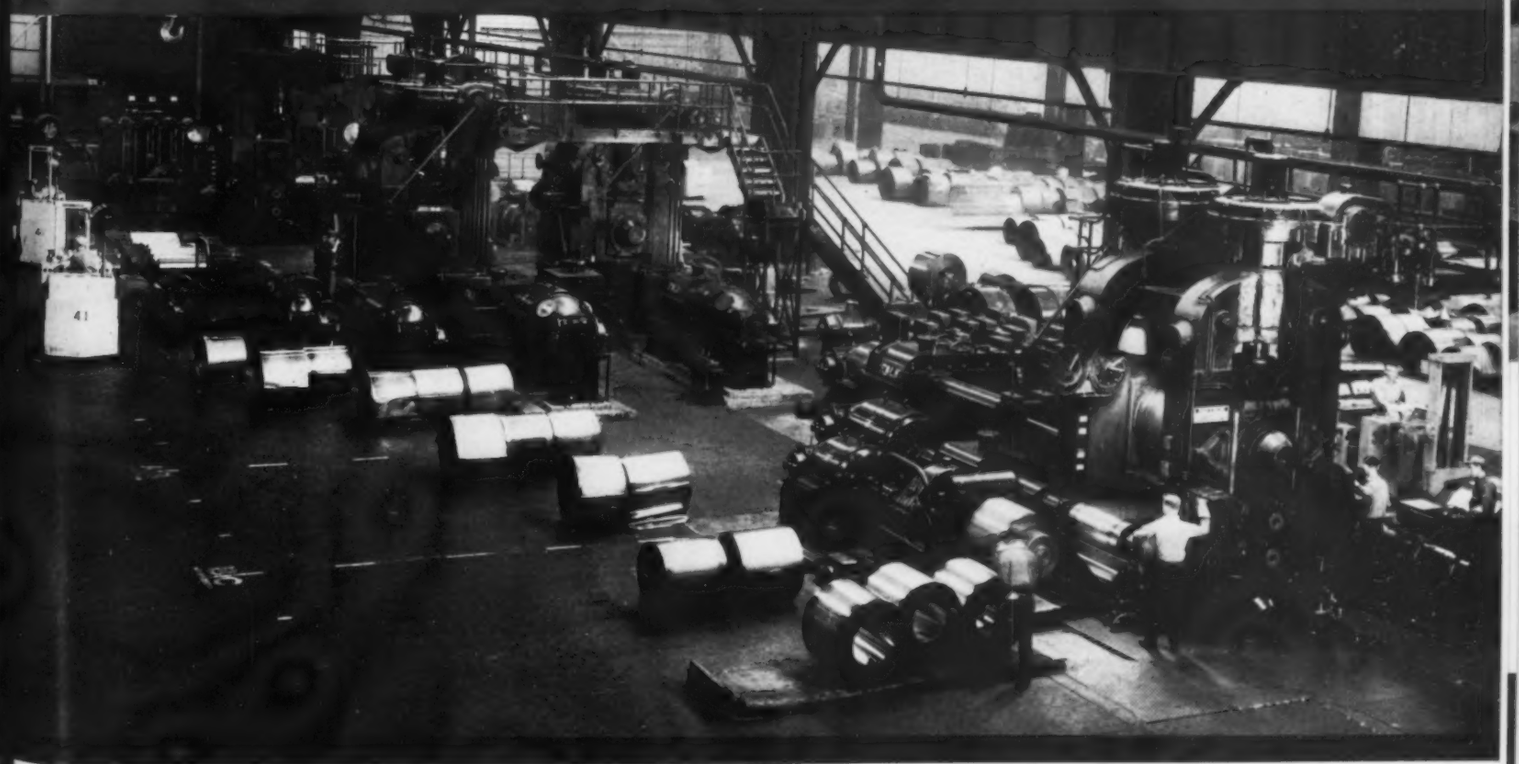
S at RVIN Works

BLISS
SINCE 1857
BLISS

84-Inch Four High Temper Mill for Sheets or Coils—Delivery End.



Tin Temper Mill Department, General View Showing 42-Inch Four High Temper Pass Mills.



ROLLING MILL DIVISION

SALEM, OHIO

HOLOPHANE

STANDARD HIBAY UNITS

STANDARD HIBAY UNITS products of Holophane Research, are used extensively by Carnegie-Illinois Steel Corporation for the newly constructed Irvin Works. One more evidence of the general acceptance of these industrial lighting units because of their efficiency, safety, permanence.

Holophane
COMPANY, INC.
Lighting Authorities — Since 1898
342 MADISON AVE. NEW YORK CITY
THE HOLOPHANE CO. LTD. 385 YONGE ST., TORONTO, CAN.

PENNSYLVANIA TRANSFORMERS

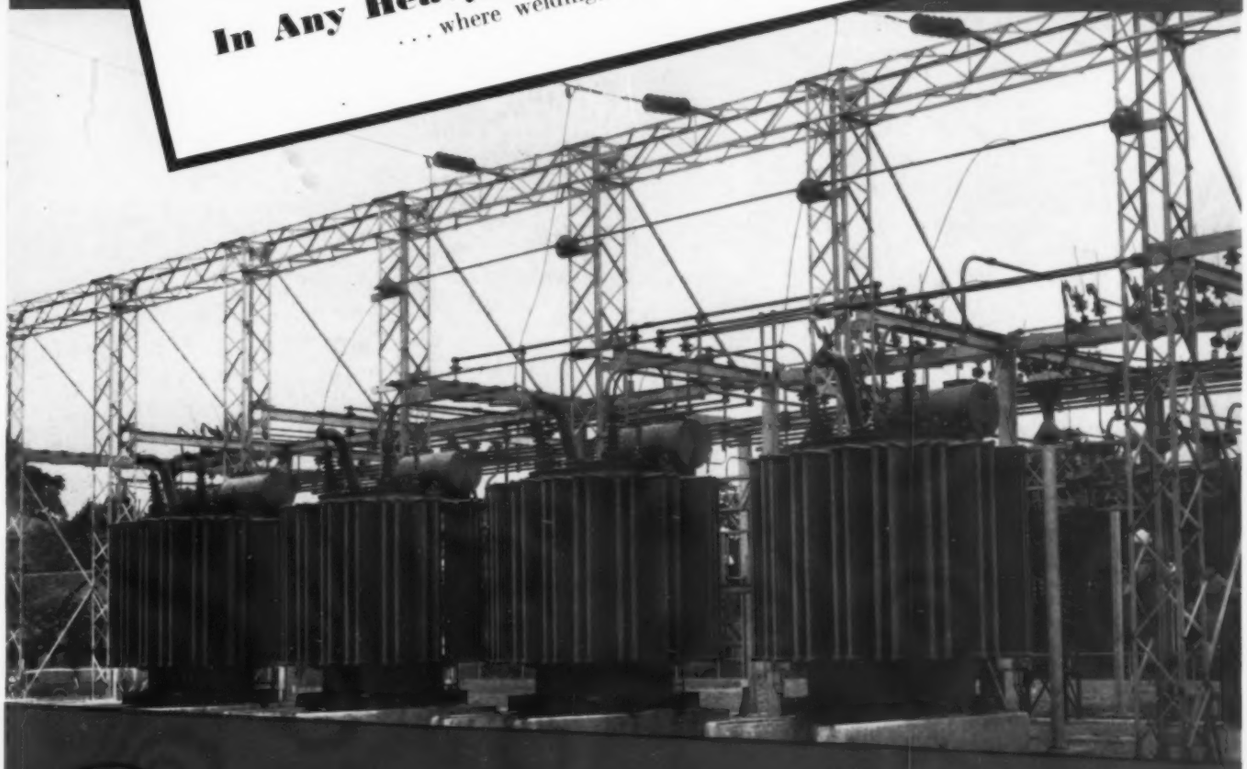
Industry's Choice

In Steel Mills
. . . where continuous processes demand unfailing power supply

In Iron and Steel Foundries
. . . where huge electric furnaces turn out tons and tons of steel

In Chemical Process Plants
. . . where the work involves heavy amperes at low voltages

In Any Heavy Industry
. . . where welding, heating, annealing or melting is required.



Above—70,000 KVA Pennsylvania Installation

Because of long years of specialized experience, Pennsylvania can build the transformer best suited to your particular requirement. Feel free to call upon our extensive engineering and production facilities.

Pennsylvania TRANSFORMER COMPANY

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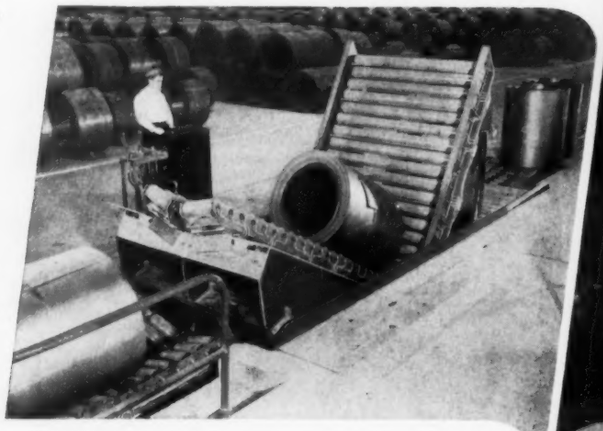

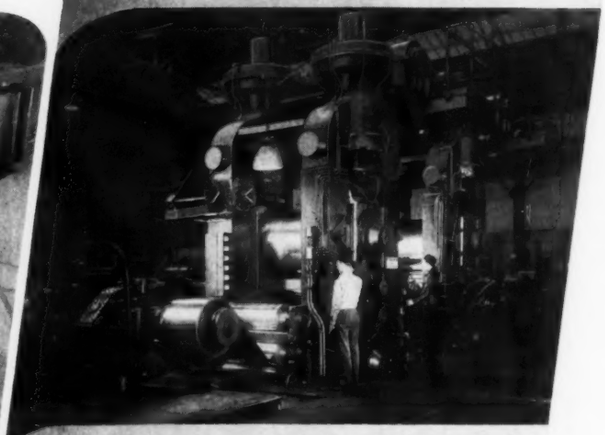

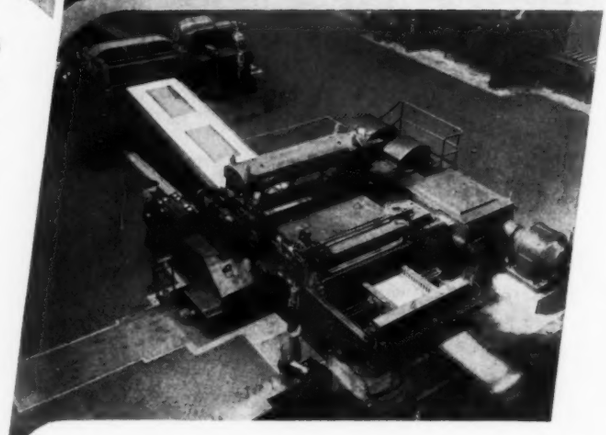

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PREPARATION of SEMI-FINISHED STEEL

By A. P. SPOONER

▲ THE demands of users of steel for lighter weight parts are the principal reasons for the intensive conditioning of semi-finished steel as carried out at the present time.

As the strength of steel increases, the detrimental effect of surface defects becomes more and more pronounced. Surface discontinuity in the softer grades of steel tends to weld up during the hot reduction operation. As carbon or alloy content of steel increases, the weldability of the steel decreases. The higher strength steels must have surface defects removed before they are rolled or forged into final shape.

The modern trend of steel fabrication requires greater freedom of surface defects because of operations involving light machine cuts, hot and cold forging methods, drastic heat treatment, etc.

The steelmaker occasionally conditions the surface of semi-finished steel as a method of salvage. The method and degree of surface preparation is mainly dependent on the subsequent processing of the steel product and the ultimate use in service. Four methods of cleaning the surface of the steel are used so that defects may be seen more readily. Surface defects which necessitate surface preparation of semi-finished steel are due to two causes, metallurgical and mechanical.

HAND CHIPPING

This, like other methods of conditioning semi-finished steel, is carried out to different degrees of perfection to accommodate the desired service on the part of the rolled or forged product.

Pickling prior to chipping greatly increases the cost of the preparation operation. Specifications of semi-finished steel products often limit the amount of chipping that can be done. All chipping marks or grooves must be well flared to prevent subsequent defects. Two types of chisels are in general use. It has been found economical to use high grade steel and properly heat treated chisels.

GRINDING

A slow and costly operation under the best conditions, but under certain conditions the most economical to perform.

The speed and type of grinding wheel used depends on the grade of steel to be ground, the purpose being to remove the maximum amount of metal with minimum danger of harming surface of the steel.

PROGRESS of LUBRICATION IN THE STEEL INDUSTRY

By C. C. PECU

▲ THIS paper covers briefly the history and development of lubrication engineering in the steel plant. In the early days, lubrication and lubricants were rather crude, and short life and high repairs on equipment were a matter of course. About 1910, far-sighted engineers began to recognize that much of the lost time, excessive repairs and high power losses might be eliminated by proper lubrication, and steps were taken to effect this.

It took years to accomplish the objective of this campaign, much of which was purely pioneering in a new field. Moving parts of equipment were gradually enclosed, and the methods of applying lubricants were improved. Lubricants were also improved, but this is probably not as important as the development of

appliances for their application. The design of plant equipment has undergone a refinement resulting in greater ease of effective lubrication. Modern mills have imposed more severe duty upon lubricants, which has been met by new developments in lubricant quality and characteristics.

The results are almost unbelievable. Efficiency and economy have resulted from the longer life, and lower repairs, of plant equipment.

Appended to this paper is a complete list of lubricants used in a steel plant, giving the application and the type and characteristics of the lubricant for that application.

MODERNIZATION of EXISTING OPEN HEARTH FURNACES and AUXILIARY EQUIPMENT

By G. L. DANFORTH, JR.

▲ THE purpose of the paper will be to discuss the design, construction and physical condition of existing open hearth furnaces and auxiliary equipment, with suggestions and illustrations as to when, how, and to what extent they may be modernized with such expenditures as will be justified by the results obtained thereafter in increased production, lower operating costs, and improved quality of the steel products manufactured.

It will be presented that existing open hearth furnaces and equipment may be classified in accordance with their present over-all condition in several groups, such as modern, semi-modern, or quite obsolete, and that for each of such groups, other than the modern group, there are now available designs, equipment and coordinating arrangements which can be used advantageously to modernize to whatever extent may be justified by the improved results in operation relative to the financial investment required for such modernization.

It will be presented also that modernization is a continuous process, and that with the improvements continuously being developed and made available for use, even the open hearth units now classified as modern will be subject from time to time to alterations or additions.

The major features now available for modernization will be mentioned, and in conclusion, it will be stated where, and under what conditions the use of each such feature or combination of such features may or may not be considered to be justified by the over-all results relative to the amount of investment required.

BILLET GRINDING

By A. ROUSSEAU

▲ GRINDING is one of several recognized methods of removing surface defects from steel billets. Other methods, however, call for a preliminary cleaning operation to disclose all but the widest defects, whereas grinding both cleans the surface and removes the defects which are thereby uncovered.

With certain kinds of steel, such as self-hardening tool steel, chrome-nickel, high chrome and other alloy steels, grinding is the only really satisfactory method of cleaning the billets and removing the defects. On other classes of steel other methods, utilizing pickling to disclose the cracks, and chipping or scarfing to remove them are sometimes used. The only advantage claimed for the other methods is lower cost, but with present-day improved grinding wheels, and with proper attention to methods and to selection of the best speeds and pressures, grinding costs can be kept down to the point where the advantage if any of the other methods is very small indeed, and with an all around improvement in the quality of the work.

The two most important factors affecting the economy of billet grinding are wheel speed and grinding pressure. These are both discussed in considerable detail and can be briefly summarized as follows:

WHEEL SPEED (Constant Pressure)

Rate of cut and rate of wheel wear are proportional to surface speed of wheel. Wheel wear per unit of work ground remains constant regardless of wheel speed. Economy is gained through the higher rate of production.

Most important limiting factor is strength of wheel.

GRINDING PRESSURE (Constant Speed)

Higher pressure increases rate of cut, and as in the case of higher wheel speed, the rate of wheel wear in like proportion. Practical gain appears to be greater with organic than with vitrified wheels and appears in the form of faster production.

Here also an important limiting factor is the strength of the wheel. Fatigue of the operator must also be taken into account. Pressure must always be kept low enough to allow the operator complete control of the operation.

Tied up closely with these two mechanical factors is the important one of proper selection of wheel grade. It is a well established fact that a softer wheel, under the same pressure and speed, cuts and wears at faster rates. However, when a softer grade is used to increase rate of cut, increase in rate of wear is greater than that of cut. Consequently, time charge per unit of work diminishes while wheel cost per unit of work rises.

Due to difference in cost accounting methods in different steel mills, careful study must be given so that a proper balance between all of these factors can be obtained, in order to achieve the greatest possible economy. The best wheel and operating conditions in one mill may not necessarily be the best in another mill, even though the steel is exactly the same.

Because the factor of safety is definitely affected by changes in wheel speed, grinding pressure, and wheel grade, this is discussed in considerable detail. The important difference between the established factor of safety and the true factor of safety is explained. The importance of proper attention to mechanical guarding is also stressed.

RECONSTRUCTED BLAST FURNACE SHELL OF WELDED DESIGN

By L. J. GOULD

▲ BLAST furnace "F" at Maryland Plant of the Bethlehem Steel Company had been changed in size and capacity and the lines were varied at different relinings until those dimensions were achieved which seemed to give the best operation. Unfortunately, it developed that the lining was too thin at an area between 10 and 20 ft. below the wearing plates.

It was discovered that if the existing mantel diameter were held and a 4 ft. 6 in. high cylindrical shell were erected at that point, and from this cylinder a conical shell was built that attached to the existing hemispherical top, a gain in thickness of brick of 14 in. could be made at the weak point.

It was therefore decided to erect a new shell from the mantel to the hemispherical top. This shell was electric buttwelded except at the joint at the top. Flans were made so that the new shell plates were erected around the existing shell plate and the whole load of the top and downcomers was transferred in steps to the new shell. The old shell was then dismantled from inside.

The operation was carried on successfully while a regular relining of the furnace was in progress. When all of the stock, brick and salamander were removed, a tight scaffold was placed inside at the mantel. By the time the bricklayers had finished all but the last three feet of the bosh, the steelwork was finished. Thus only the time required for placing and removing the scaffold was lost on the lining.

The shell has a pleasing appearance and is free from the rivet heads and vertical buttstraps and therefore easier to clean and paint, and requires less cutting of brickwork. There seems to be no question of the desirability of welded stacks.

STEEL CONDITIONING WITH THE OXY-ACETYLENE METHOD

By G. D. WINLACK

▲ THE conditioning of the semi-finished materials preparatory to the finishing rolling has always been and perhaps always will be a major problem for most of the steel producers. In the past practically all of the defects in the semi-finished steel were removed by either manual or mechanical chipping or in some cases where steels were too hard to chip by grinding. Numerous efforts were made along many various lines of thought in order to try and increase the low efficiency of hand chipping operations thereby reducing the corresponding high cost per ton involved.

The high cost was not only contingent on the slowness of the operation, which necessitated many hours of manual labor, but also on the high cost of maintenance and replacement of essential equipment used. It cannot be denied that hand chipping was and still is a crude, slow, expensive and unsatisfactory method of steel conditioning and has only existed because the producer had nothing better to switch to.

Reaching out for other means to speed up production and to reduce high chipping costs, swing grinders were brought into the picture. However, the vogue did not last long, due to increased instead of a decreased cost, plus the inability of the wheel to go after deep cracks and defects and the restricted limit of its portable flexibility necessitating high material handling costs. Swing grinding is at present and undoubtedly always will be the most costly method of cleaning steel mainly due to slowness of the operation which makes labor costs too excessive plus high cost of grinding wheels.

In further efforts to cut down high hand chipping costs, steel producers have spent large sums of money experimenting with various methods of mechanical chipping. Mainly, the experiments have consisted in the use of large and expensive machines employing machine tool principles. Some of these machines did offer some relief over hand chipping, but all of them have certain general disadvantages which hinder them from being the relief expected. One of the main disadvantages is their dimensional limitations. If the machine is sturdy and big enough for ingots, slabs and blooms, it is far too cumbersome for the working of billets. On top of this, is the high cost of operation and high maintenance costs of tools, plus high initial installation costs.

A newer method of cleaning semi-finished steel is deseaming with the oxyacetylene torch or what is commonly known as "scarfing". Actually scarfing is burning out enough of the steel in vicinity of the defect so

as to remove same and still leave the surface of the steel in such a condition that it can be rolled into satisfactory finished product.

The use of deseaming or scarfing for removal of defects from the surface of ingots, slabs, blooms and billets has increased rapidly during the past few years. In fact the operation has increased so fast that the tonnages now cleaned by this method far exceeds that which is cleaned by chipping. It is no exaggeration when it is said that scarfing is revolutionizing steel cleaning practice.

Development of deseaming techniques for various size sections and grades of steel along with better torches and tips plus auxiliary starting equipment has advanced to the point where today deseaming is being done on practically all grades of steel which burn under an oxygen stream and in all sizes down as small as 1½ in. x 1½ in. billets, both on plain carbon and alloy steels.

The flexibility of the deseaming torch is such that several plants are using the process for hot scarfing of large defects from blooms, slabs, etc., at the mill while material is in process of being rolled. In plants where this type of deseaming is applicable the large economies available are plainly self-evident.

Torch deseaming when compared to chipping offers several advantages, the most important being as follows:

1. Speeds of at least ten times faster resulting in lower conditioning costs.
2. Ability to salvage many stocks which formerly were scrapped due to prohibitive cleaning costs by any other method.
3. A reduction in inventory, stock handling facilities, in delays in stock assembly for rolling mill schedules, thus expediting shipments to customers.
4. The facilities to condition, blooms, bars, billets and slabs to insure perfect quality surface when reworked to finished product.

The need for a rapid and inexpensive means of completely removing the surface of steel stock, either cold or at rolling heat, in the intermediate stages of processing has long been recognized by the steel industry. The extension of the principle of oxy-acetylene torch deseaming to include mechanically operated multiple torch equipment capable of "desurfacing" or "skinning" one or more surfaces of the steel stock with each pass provides the sought for answer to this problem.

Because of the high speed and accurate control of the surface removed, the cost of machine skinning is considerably lower in relation to the area desurfaced than that obtained with hand deseaming. It is therefore, frequently more economical to remove the entire stock surface with a desurfacing machine, rather than merely to hand scarf the more defective areas. Machine desurfacing allowing the removal of the entire surface of the hot stock as it moves through the mill offers the possibility of finish rolling the stock, without cooling for intermediate inspection and marking, with large economies through the elimination of handling and reheating.

Gradual recognition that thermal scaling of ferrous metals is a cause of manufacturing difficulties, has resulted in rapidly spreading interest in means for the swift removal of surface accumulations of this kind. The presence of scale on steel billets prevents close inspection for locating of minute defects and fine seams prior to flame scarfing or chipping. Heretofore, pickling has been largely used to descale billets, blooms slabs, rounds, barstock and frequently ingots.

The flame descaling process employs the use of the oxy-acetylene torch in combination with brust type tips, which are traversed over the surface at the proper rate of speed to remove the maximum amount of scale. By means of the high temperature thus applied a differential expansion results causing the scale to lift, crack and fly off in particles from 1/16 to 1 in. cross dimension depending on type of steel and section cleaned. The process may also be used to supplement the pickling operation in that the greater amount of loose scale may be flame descaled and the remaining lesser amount removed in a brief pickle with acid of reduced strength.

OBSERVATIONS ON THE HEATING OF STEELS FROM THE METALLURGICAL VIEWPOINT

By E. E. CALLINAN *and* GILBERT SOLER

▲ THE purpose of the paper is to discuss some of the factors affecting the heating of steel and other problems, such as blooming mill defects, which are closely allied with them.

The effect of alloy content on the correct heating temperatures in soaking pits is illustrated and it is shown that except where an alloy has produced a change in the structural properties of the ingot, the temperature is predominantly a function of the carbon content, as in plain carbon steels. A chart of pit temperatures for several grades of alloy steel ranging from .08 to 1.50 carbon is included, as are several examples of compositions which do not follow the carbon curve.

The effect of the coefficient of thermal conductivity as varied by alloy content is discussed. Use of the Grober curves is made to emphasize that the surface temperature of steels of low thermal conductivity quickly reach equilibrium with the heat source and that consequently the early stages of the heating cycle necessitate proper care and control.

The relationship between heating practice in a modern soaking pit and surface conditioning (chipping) costs is illustrated by several charts of typical alloy steels, in which the chipping cost is plotted against such factors as draw temperature, stabilization time, track time of the ingots, and total heating time.

The paper is concluded with photographs of types of bloom surface defects and a discussion of their causes.

GAUGE CONTROL FOR COLD STRIP MILLS

By F. MOHLER

▲ THE gauge or strip thickness produced on a cold mill is becoming a problem of ever increasing importance. Gauge control is a subject, not a gadget. It embraces all of the multitude of causes of gauge variation and how they can be controlled. The interrelation of these causes is complex, and not too much is known of their relative importance. The purpose of this paper is not to break down all of these causes and study them individually, but to deal with their combined effects and means for their control.

In order to control gauge, it is necessary to know something of the possible causes for variation. The predominating, in all probability, are roll shape, cooling solution, lubrication, speed, variations in incoming strip, and tension.

The combined effect of all the various causes of gauge variation is radically different during acceleration and deceleration, as compared to the steady rolling condition obtained at running speed.

With a modern mill of good design and good rolling practice, it appears from observation and practical tests that the predominating cause for variation in gauge while at running speed is the variation in the incoming strip.

Although the factor of prime importance that causes variation in gauge while running, appears to be variations of the incoming strip, this factor slips into the background and the combined effect of variations caused by different rolling speeds becomes predominant during acceleration and deceleration. It is an observed fact, and proven by practical experience, that if a mill is set up to be on gauge at a certain speed, and if the screw settings, cooling solution, lubrication, and so forth, are left fixed, the gauge will become heavy if the speed is decreased, and light if increased. This is true, whether of a transient nature, such as during acceleration and deceleration, or a steady state condition.

Apparently there is no clear and exact explanation of this phenomenon, and if there is, the author has been unable to uncover it. In face of this, it may not be presuming too much to hazard an explanation of possible causes. This, at least, might interest some individual to do some spade work and discover the true, or at least the predominating cause:

1. Variation in the degree of identation of the working roll.
2. Variation in roll temperature.
3. Variation in lubrication.
4. Rate of deformation.

It seems sensible that the first consideration in reducing "off" gauge is to make the mill inherently correct by obtaining fast accelerating and decelerating rates and using as large coils as possible. This cuts the potential "off" gauge to a minimum before any thought of fancy control is considered. Not only is this accomplished, but the possible production rate is increased also.

Another important factor which should not be overlooked in selecting the motors so they will be inherently correct, is to taper their ratings in accordance with the actual schedules to be rolled.

Now, what special control can be used to attack the remaining "off" gauge? From the foregoing discussion of the causes for variation in gauge, it is obvious that the only way to attack the increased thickness at lower speeds is to increase tension during acceleration and deceleration or operate the screwdowns. Furthermore, since gauge is a function of speed, the tension should be greater at threading speed, and gradually taper to the "running" value as the mill is accelerated up to "running" speed.

This may be accomplished in either of two ways: by counter electromotive force exciters in the motor fields, or by booster generators in series with the motor armatures.

Recapitulating, the fundamental requirements for good gauge control that should be incorporated in every mill are:

1. Good hot strip.
2. Large coils.
3. Shunt wound motors rated on a 40 degree force ventilated basis and in accordance with the schedules to be rolled; and, with speeds and inertias so selected that a maximum of 40 per cent current is not exceeded when accelerating them together with their respective mills to maximum speed in 10 seconds.
4. Tensiometers for indicating the tension between stands.
5. Vernier rheostats for accurately adjusting the speeds and therefore the tension between stands.
6. "Tapered tension" control for obtaining increased tension between stands at threading speed and gradually tapering it to the "running" value as the mill is accelerated to the "running" speed.
7. Inertia compensation when higher than recommended accelerating currents are used or when the inertias of the motors are not matched properly.

Additional requirements if the off gauge is to be reduced to a minimum:

8. "Automatic gauge" control.
9. Screwdown follow-up control for No. 1 stand.
10. Line boosters.

In conclusion, it is safe to say that if a mill is equipped with the fundamental electric equipment outlined and good rolling practice is used, the results will be quite surprising. Poor rolling practice can cause more "off" gauge than all the electric gadgets can possibly save. The "electric cures" can assist, but are not "cure-alls".

CAUSE OF GEAR WEAR AND FAILURE

By J. H. JONES

▲ THE purpose of the paper is to point out ways and means by which service life of steel mill gears may be improved. The author believes and sights cases to prove that gratifying results in terms of gear life can be had through greater precision in manufacturing, slight modification of tooth form, more attention to heat treating of gear blanks and finished gears.

The subject of gear tooth wear and failure is divided into five (5) separate types of tooth destruction. These are:

1. Abrasion or common wear.
2. Pitting.
3. Scoring.
4. Surface flow.
5. Tooth breakage.

The author gives his views in a brief discussion of the common cause and remedy for each. He also believes that a more thorough study of gear operation would make possible a maintenance of such caliber that the life of gears now in service would be appreciably increased.

Without touching on general gear design or items that would greatly effect the cost of manufacturing, the author has attempted to point out numerous ways of obtaining increased life from current gear designs. The ever increasing demand for higher speeds and loads at lower costs indicate the need for development along these lines.

YIELDS OF COKE AND BY-PRODUCTS FROM VARIOUS COALS

By J. D. DAVIS

▲ THE paper deals with the yields and quality of carbonization products from various coals as determined at low-, medium-, and high-carbonizing temperatures by a standard test method developed by the Bureau of Mines in cooperation with the American Gas Association. This method consists in carbonizing charges of coal in welded steel retorts in an electric carbonizing furnace of which the temperature is controlled automatically. All carbonization products are recovered and subjected to complete chemical and physical examination.

The aim of the method is to compare the carbonizing properties of different coals by the same procedure rather than to duplicate exactly the performance in any given type of carbonizing plant. The paper shows how carbonizing properties of coking coals vary with their rank and type and the effect of carbonizing temperature on results obtainable. The effect of artificial weathering on carbonizing properties is illustrated. The bearing of expanding properties of coal on practical coke oven operation and the relation of plastic properties of coals to the mechanism of coke formation are discussed.

High-temperature carbonization tests for the groups of low-volatile, medium-volatile, high-volatile A, and high-volatile B coals respectively, that were selected for comparison gave the following average yields of products on the moisture-, and ash-free basis: Coke, 83.3, 75.6, 70.0, and 64.1 per cent; tar, 4.4, 11.4, 15.5, and 13.5 gallons per ton; gas, 2910, 3180, 3500, and 3520 Btu. per pound of coal carbonized; light oil, 1.38, 1.86, 3.35, and 3.37 gallons per ton; ammonium sulphate, 17.1, 19.4, 20.2 and 27.6 pounds per ton. Thus it may be concluded that the variation in products obtained with rank of the coal is fairly regular. The strongest coke was obtained from the medium-volatile coals, although that from the low-volatile coals was almost as strong; the coke from the high-volatile B coals was considerably weaker than that from the other groups. The best gas was obtained from the high-volatile A coals which are known industrially as gas coals. The tar acid content of the tars increased and their aromatic content decreased with decreasing rank of the coals.

Splint coal is distinguishable from bright coal in thin translucent sections under the microscope. The splint is highly opaque and contains a characteristic large spore. Splint coal containing a large number of spores will give larger yields of volatile products than bright coal. Its main carbonizing characteristics are failure to swell on coking and production of weak coke. Blending it with a reasonable amount of suitable blending coal can result in production of a satisfactory furnace coke.

Carbonizing temperature has a pronounced effect on the yields and properties of carbonization products. As the temperature is raised from 500 to 1,000 degrees C., the yield of gas increases almost linearly from 2,400 to 11,900 cubic feet per ton for a representative medium-volatile coal, or nearly 100 cubic feet per ton for each

10 degree variation in the carbonizing temperature. However, its heating value decreases in about the same proportion. The yields of tar decrease rapidly with increasing carbonizing temperature and their chemical nature is changed from paraffinic to aromatic. Yields of coke decrease and tend to approach a constant value at the 800 degrees C. effective wall temperature. Coke of best quality is produced at this temperature; at higher temperatures development of shrinkage cracks tend to weaken it.

In general, weathering gradually destroys the coking power of a coal, but with high-volatile coals that become very fluid in the plastic state, moderate weathering may be beneficial; that is, they become too fluid for production of the best coke and weathering reduces their fluidity. A good index of the extent to which a coal has weathered is the decrease in the yields of tar (compared to that from fresh coal) obtained on carbonization.

The expansion of coal during coking is a matter of great importance industrially. Low- and medium-volatile coals may exert enough expansive force to ruin a coke oven unless blended with appropriate amounts of high-volatile shrinking coal. The temptation to use these coals is great because they produce strong blocky cokes. Unknown coals or blends in this range of rank should be tested by a laboratory method such as that used by the Bureau of Mines before charging into a battery of ovens. High charge densities must be avoided with such coals as the expansive force increases rapidly with the density of charge.

It is suggested that coals be classified in respect to their plastic behavior as fluid and viscous. Viscous coals include low-volatile and some medium-volatile coals. Such coals exert a high expansive force during industrial coking, the reason being the high resistance developing to escape of the gases and vapors generated in the plastic coal. Fluid coals are found mostly in the high-volatile A rank group. They shrink during industrial coking. They are too fluid in the plastic state for production of coke of the highest quality; weathering reduces their fluidity and therefore limited weathering tends to improve their coking properties.

A DOUBLE-BUS SYSTEM FOR POWER TRANSMISSION

By D. I. BOHN *and* J. E. HOUSLEY

▲ POWER transmission systems vary widely, principally in the extent to which flexibility of switching to meet all assumed conditions is carried. The Alcoa power system, comprised of 265,000 kva. of generation in three power houses, feeding a normal load of 200,000 kw. to the reduction plant, leans in the direction of simplicity.

The system, as will be observed from the wiring diagram, is essentially in its electrical features a double bus supplied from the three power houses. Each power house constitutes a tap on the transmission system and, as mentioned, may be considered as a bus in as much as the transmission lines do not loop in and out of the power houses.

There are certain switching combinations to take the equipment and lines out of service that cannot be done to the extent that a loop system would permit. In spite of this, it is the opinion of the operating personnel that the problems presented by this slight lack of flexibility have been less important than the problems which would exist due to the complexity of the looped-in switching system.

A typical station auxiliary scheme is described, the main feature being that no 13 kv. auxiliary switching is done but individual auxiliary transformers are provided for each unit, any one of which handles the station load.

MODERN LUBRICATION OF EXISTING EQUIPMENT

By F. J. THOMAS

▲ THE term "existing equipment" naturally includes all equipment now in use. It is desirable that such equipment be lubricated in a modern or efficient manner. The efficiency desired should be as close to perfection as possible and this is reached when several apparently conflicting results are obtained together.

Numerous obstacles preventing efficient lubrication may be found. Among them age and poor design coupled with the expense required to modernize are important.

A wide variety is noted in the methods of lubricating bearings, both with oil and with grease. These methods range from the very simple to the very complex, from the crude to the very efficient. Brief descriptions of some of these methods and their applications to various units are included in the paper. Examples are given of changes from one method of lubrication to another with results noted.

Changes in equipment and bearing design, or in types of bearings used, are often very effective in making possible more efficient lubrication. Some possible and less expensive changes of this type are mentioned.

The paper as a whole attempts to cover many existing lubrication practices and points out means by which these may be improved. In very many cases improvements can be made without great expense which will pay attractive dividends in reduced maintenance costs.

MECHANICAL BILLET CHIPPING

By G. W. LENTZ

▲ IN this paper an analysis is made of the hourly charges against the mechanical chipping machine, including operator, inspector, craneman, laborers, supervision, repairs, power, tool costs, compensation, depreciation, etc.

Production tests and time studies as conducted on various cross-section sizes and analyses of billets, covering a rather extensive range, is given, together with tool costs and treatment, and the methods of grinding tools, as applied to the mechanical chipping machine for the most economical results.

Power costs as applied to this unit will also be included, showing the remarkably low cost of power required on the mechanical method as against other methods. The electrical equipment will also be discussed, with explanation as to the various speeds relating to the tool head and the longitudinal movement of the carriage, together with the master joy stick control designed especially for quick action. Mention will also be made of the rapid duty cycles imposed on the tool elevating motor and carriage drive motor.

A motion picture will also be presented showing action pictures of the mechanical chipping machine, with a comparison to hand chipping and scarfing. The pictures also illustrate the handling and auxiliary equipment of the mechanical unit, as well as the disposal and separation of the chips.

POWER REQUIREMENTS OF COLD STRIP MILLS

By A. F. KENYON

▲ WITHIN the last ten years, the cold reduction of steel strip has developed from a process used only for the small-scale finishing of certain specialized products to its present status as the most important method of finishing all classes of flat rolled steel, including light gauges for tinplate, intermediate gauges for galvanized roofing stock, and heavy gauges for automobile body and fender sheets, etc. With this rapid development of equipment and operating practices, and the continuing installation of new mills and the modernization of existing mills, we believe that many members of the Association will be interested in power data which has been accumulated from a number of different cold mill plants, to indicate the performance which is being obtained on existing mills, and to guide the selection of equipment for new mills.

Information concerning the equipment installed on other similar mills is often helpful in making up preliminary estimates, and also as a check on later detail calculations. Tabulations have been prepared listing most of the multi-stand tandem cold reduction strip mills, now numbering more than thirty; and for each mill are listed the size of mill rolls and reel, ratings of mill and reel motors, and main motor generator set, gear ratios, mill speeds, etc. Much of this information was previously available in the descriptions of various mills published from time to time and the consolidation of this data into tabular form will serve to make it more convenient for reference.

Power calculations to determine the probable loads which will be imposed on the mill and reel motors by the rolling of a particular product at some specified rolling speed and with specified reductions in the individual passes, make use of test data obtained from similar mills doing approximately the same work. To be generally applicable, the test data must be reduced to the basis of energy units per unit amount of rolling work, and plotted in the form of curves, from which may be read the values to apply to the particular conditions specified for the proposed new mill. The method of preparing the energy consumption curve from a typical set of test data is described in detail, also there is presented a typical power calculation to show the use of data from the energy consumption curve to determine the motor loads for another rolling schedule. Many hundreds of tests have been made on more than twenty different tandem and reversible type cold reduction mills, and the energy consumption curves prepared from these tests are included in the paper, to enable power calculations for the rolling of various classes of products.

Estimates of expected average power system demand and gross kwh. consumption require additional data as to the probable hourly and monthly tonnage output rates, and kwh. per ton energy consumption rates, for the particular products to be rolled. The operating records of several different steel plants have been analyzed, and data obtained as to the maximum and average mill output, and kwh. energy consumption, and data covering the rolling of both tinplate and heavier gauge strip will be presented.

THE TRANSITION FROM 25 TO 60 CYCLE POWER IN THE STEEL INDUSTRY

By W. B. SKINKLE

▲ WITH the development of long distance alternating current power transmission came the desire to apply alternating current directly to the motor drives of such steel plant equipment. There followed a number of years of development of alternating current equipment.

At the time of this early development, gear reduction sets were of relatively low efficiency, so that in order to obtain the low speeds desired and yet have reasonable diameters of motor and generator armatures, 25 cycle power seemed the economical selection. This followed the precedent already established by water power developments at Niagara Falls and other places.

Subsequent strides in improvement of steam-electric generating plants, of reduction gearing and other equipment resulted in a trend toward 60 cycle power, which was adopted by the utility companies, and has become the recognized standard of the United States. Thus, companies operating 25 cycle systems find themselves more and more in the position of operating isolated power systems.

Such was the position of the United States Steel Corporation in the Pittsburgh district, where, up to 1937, all corporation works in the lower Monongahela valley used 25 cycle power for their main electrical supply. Only incidental use of 60 cycle power was made at a few places where small quantities were purchased. The various plants were inter-connected by a 25 cycle transmission system.

When it was decided to build a continuous strip mill in the Pittsburgh district, power became a major factor and was the subject of careful investigation. It was developed that additional power supply was necessary which could be either of 25 or 60 cycles. The reasons for the choice of 60 cycle power are enumerated in detail in the paper, and include considerations of cost, greater freedom in selection of equipment and selection of source of power, efficiency, and frequency changers.

The selection of 60 cycle power for the new projects brought the first step in the development of a 60 cycle transmission system, which will ultimately use a combination of purchased power and company-generated power. Tentative plans of this system call for no major additions on the 25 cycle system; the transfer of 25 cycle load to the 60 cycle system as 25 cycle generating equipment is retired from service; and the 60 cycle system will be extended for new major additions.

For an economical change-over, the transition period will probably extend over twenty-five years. When passing through such a transition period, occasions will arise where the change may entail a temporary loss until the economies of the complete program are available.

The economical shifting of loads and the maintenance of uninterrupted production during the transition period presents many problems. Study has developed plans whereby a series of steps may be arranged over week-end periods, involving no general plant shut-downs. Such changes naturally result in "mixed cycle" plants, but experience in plants having this condition indicates no more reason for confusion than might exist with pipe lines for various services or with the a-c. and d-c. systems installed in all steel plants.

THE WELDING OF RAIL ENDS AND JOINTS OF CRANE RUNWAYS

By WRAY DUDLEY

▲ THE paper is in the nature of a preliminary report concerning the experience gained during the past year in welding crane runway rails.

It presents data showing characteristic rolling loads in different types of service, illustrates the nature of failures usually encountered, and describes the various weld procedures for repairs and replacements which were attempted, including the building up of low and battered ends, and the making of semi-continuous and solid welded joints.

Service results and costs of the various groups of welds are presented, and an attempt is made to evaluate the economic use of welding for crane rail applications.

AUTOMATIC ATOMIC HYDROGEN WELDING OF STEEL

By J. T. CATLETT

▲ THE paper gives a brief history of iron and steel, emphasizing the demand engendered by expansion of the transportation industry, and traces a brief history of the development of welding.

An explanation is given of the atomic hydrogen welding process, covering hand welding and the variables controlled by the operator, the single-arc automatic welding equipment and the methods used to control the variables; and the multiple-arc equipment and the methods of its application to the tube welding problem.

The use of dissociated ammonia as a substitute for hydrogen is discussed.

A chart of welding data is developed for the single-arc, the 3-arc, the 6-arc, the 10-arc and the 15-arc equipment, giving welding speeds in feet per hour and in tons per hour, and welding costs per foot and per ton using either hydrogen or dissociated ammonia.

WELDING ELECTRODES AND THEIR APPLICATIONS

By J. H. DEPPELER

▲ IN general, the electrodes for welding iron and steel consist of mild steel core wires covered with a carefully designed mixture of mineral oxides and silicates with or without a percentage of combustible material, all carefully selected as to analysis and particle size so as to:

1. Vaporize or burn, and thus shield, the materials being transferred across the arc from the oxygen and nitrogen of the atmosphere. The importance of this is that it not only avoids the introduction of oxides and nitrides into the weld metal but also conserves the elements which have so important an effect on the physical properties of the weld metal.
2. Offer sufficient resistance to fusion to create and maintain on the end of the electrode a symmetrical and inverted crucible neither too deep nor too shallow. The mineral or inorganic ingredients of the covering are essential to protect the organic or combustible materials from premature decomposition.
3. To continuously furnish to the arc materials to control its resistance and, therefore, the arc voltage, and others to stabilize the arc, cause it to operate smoothly, without wandering or spatter.
4. To furnish those mineral oxides and silicates which will produce on vaporization and subsequent solidification a complete dark spongy slag blanket, so light and porous that it cannot depress or deform the weld metal but with a smooth top surface completely excluding the gases of the atmosphere: a slag which, on cooling, will shrink away from the weld metal and because of its fragility, be easily cracked and brished away. This slag blanket on the weld metal also serves to retard slightly the solidification of the weld metal and thus to allow gases to escape.

The most suitable core material for iron electrodes is a high grade rimmed steel; killed or semi-killed steels do not seem to function as well. Specifications usually call for:

Carbon	.13 to .18 per cent
Manganese	.40 to .60 per cent
Silicon	.06 per cent
Sulphur	.04 per cent max.
Phosphorus	.04 per cent max.

The carbon and manganese contents affect the tensile strength of the weld metal and to some extent the smoothness and soundness but the sulphur content is all important and where perfect weld soundness is required, it should be as much below .04 per cent as is reasonably possible. The phosphorus content is much less important and were it not for limitations of this element in specifications, even .07 per cent phosphorus in core wires would not be harmful.

Electrodes with more than about 10 per cent cellulose in the coating frequently give very unsatisfactory performance on alternating current, as it is most difficult to maintain an arc.

While in general the amperage used controls the rate of welding, the arc voltage affects the amount of penetration into the metal being welded. Undue penetration is usually undesirable because the penetrated portion of the parent metal mingles with the weld metal and may completely change its character.

Elements like molybdenum, nickel, vanadium, copper, chromium and tungsten are frequently used in electrode design, and may be added either through the use of alloy core wires or added through the coating. By means of their use, weld metal tensile strengths as high as 100,000 lb. per square inch combined with elongations of over 20 per cent in 2 in., or as low as 63,000 lb. per square inch with ductilities over 40 per cent in 2 in. can be obtained. Other combinations affect hardness, corrosion resistance, cavitation resistance, creep strength, low temperature impact values and resistance to fatigue.

THERMIT WELDING

In considering the physical quality of thermit steel, the first question which naturally comes up is, how can such a cast steel possibly compare in strength with forged steel and will not the strength of the welded part be only that of a similar cast steel part and not that of the original forging? This question is of the utmost importance because, if the weld be considered as having only the strength of cast steel, its application in steel mills would be very limited; but this is not the case. Forgings that have been thus welded and tested to destruction will just as often fail completely outside of the welded area as they will in the weld or in the metal adjacent to the weld.

In general, there are three uses for the thermit welding process in the steel mills:

1. The repair of broken parts, which may be indicated for economical reasons or by the saving in time in getting the mill or machine into operation again.
2. The building up of worn parts, which in many cases replaces the material worn off with one better suited to withstand the service.
3. The manufacture of new constructions or the making of old ones in a new way.

The co-ordination of the various departments of steel mills in welding work is most important if fullest benefits are to be enjoyed. It is, of course, not feasible to have a number of independent welding departments in one plant, nor is it feasible for the various mill superintendents to keep in close touch with a central welding department. This question has been solved in certain

mills by the organization of a reclamation department under a suitable head, who, together with the mill superintendent interested, has the final way as to which broken or worn parts should pass on to the scrap pile and which should be reclaimed.

CRANE RUNWAY RAIL WELDING

Increasing interest is being shown by steel mills and other plants in the welding of crane runway rail for heavy cranes. The advantages gained by doing away with joints in such rail are more or less obvious, including smoother crane operation, saving in damage to crane and crane structures, elimination of broken wheels, and reduction in maintenance of the runway rail itself. Also, in the case of collector rail, 100 per cent electrical conductivity is obtained. Because in most cases crane runway rail is bolted direct to the girder, it was necessary for us to develop for this type of work a new design of weld with no collar under the base.

DESIGN OF THE NEW INLAND BLAST FURNACE

By H. W. JOHNSON

▲ SINCE all blast furnaces are built alike in their essentials, and operated alike, it is obvious that a discussion of the general design or initial operation of No. 5 furnace would give no new lights on the subject. But some portions of the design of No. 5 furnace are different from the usual arrangements on furnaces of this size. This paper gives some of the experience and experiments that led us to select certain plans, and furnishes material from operation for judging their effectiveness.

Four areas of construction are discussed. The first is the equipment provided to prepare the coke and charge it into the furnace. The second is the factors in design which determine the radial distribution of the gases in the stock column. The third is the height of the furnace and the fourth the provisions made for heating and controlling the blast.

Coke charged into the furnace provides much of the voids in the stock column necessary for gas flow. The location of voids in the stock column determines where the gas will flow, so the more we can make the coke provide the proper voids across the entire stock column and from layer to layer to promote gas-solid contact, the better heating and reduction of ore and the more efficient the operation.

With the usual coke plant screening system, despite all care in sizing coke before charging, by the time it reaches the furnace stock line much small coke has been produced. We have found that the 4 to 5 per cent of minus 1⅛ in. coke is produced between the coke plant and blast furnace with very careful handling. The damaging effect of charging these fines into the blast furnace is generally accepted. A set of data collected at Inland substantiates the conclusions of other investigators on influence of fine coke on furnace operation. That is, that the saving in coke was equivalent to the fines screened out, or that the benefit derived was equivalent to the fuel value of the small coke.

A particular effort was made in our coke bin and skip layout, and drop at the furnace top, to insure that the coke reached the stock column in the best possible condition. This meant that the amount of drop to which the coke was subjected must be a minimum and, second, that the coke be screened thoroughly just before charging into the skips.

Furnace managers are experienced in varying operation according to materials provided, in order to achieve the best possible radial distribution. But we do not know what radial distribution is desirable; we can only judge the desirability of a certain distribution from the efficiency of the furnace at the time. The radial surveys that have been taken on No. 5 furnace will be presented. We will then present the most important factors in the design, operation and materials used which resulted in the surveys shown. And last, operating data will be presented for the periods during which the surveys were made. From these we judge the efficiency of the furnace, and then conclude as to the desirability of the measured radial distribution.

The radial distribution which obtains on a furnace is the result of combination of many factors; the most important of which is bell clearance. So, there has been a desire to establish some empirical formula or rule to determine what is the correct bell clearance or the correct ratio between the size of bell and stock line.

Unfortunately no rule for bell clearance can be established because there are many other factors which determine the radial distribution of the gases, and bell clearance is significant only in relation to the others. Some of the other influences are: the amount of straight section at the top of the inwall, the angle of the large bell, overhang of the large bell, inwall batter, speed of drop of large bell, the character of materials charged, method of filling the furnace, the amount of water charged, etc.

In general, the greater the height of the furnace, the greater the amount of hanging and slipping. The irregular movement of the stock is very damaging, so what is gained by added height is frequently lost by the greater furnace irregularity. But as the diameter of the furnace is increased, there is less friction on the walls per unit of volume, less chance of arching, and it is possible to build the larger furnaces higher without experiencing any more irregularity.

The blast furnace operates on the counter current principal and will have attained its highest efficiency when the present waste products have been used to the ultimate. When this ultimate is achieved, the top gases will issue from the furnace at about the same tempera-

ture as the incoming materials, as the reducing power of the gas will have been spent.

We have taken gas samples in furnace surveys which show in one case 20.0 per cent CO_2 and 18.4 per cent CO, and in another, 19.8 per cent CO_2 and 18.8 per cent CO. Such efficiency may be achieved in longer period of contact of gases and ore, either by slower progress of materials through the furnace or by still further increases in furnace height. But as long as water has to be charged into a blast furnace to decrease top temperature, heat is escaping instead of doing useful work and further consideration should be given to making use of this heat.

The general adoption of fine cleaned gas for use in stoves had increased efficiencies but has enlarged the possibility of failure in the top zones. Our experience has shown that stoves of standard basket weave construction with a 2½ in. brick thickness and a 5¼ in. checker opening withstand heat successfully with fillers in these flues up to 6 ft. from the top.

The conventional system of mixing hot and cold air sometimes results in nonuniformity of temperatures in the bustle pipe. Data is presented to show that better mixing is achieved by introducing the cold air in the bottom of the hot blast drum.

A steam jet was provided in the stock stack to increase the draft when it was necessary to "draft back" on the furnaces.

MODERN GAS MIXING SYSTEMS AS APPLIED TO STEEL PLANTS

By G. M. ARNOLD

▲ HEAT, like sunshine, is the vital something that helps to transform the natural elements into materials and things for the service of man. Heat from gas is now coming into more general use in steel plants, due to the availability of cheaper fuels such as natural gas and refinery gas. In order to use these gases more efficiently it is necessary to dilute them with air or some lower heating value gas to a value which would make them interchangeable with the gas used as a base fuel in the plant.

The most important characteristic of gas is its heating value—Btu. per cubic foot. So, in mixing various gases it is necessary to have an accurate measurement and control of the quality of the finished product—the mixed gas. The most important tool then, is the device which measures this heating value and does something about it. There are three such instruments in general use. One gives a continuous indication and graphic record of the heating value of the tested gas directly in Btu. per standard cubic foot. Another instrument has been developed primarily for control of gas mixing, and a third instrument has been brought out recently to indicate and record heating value for small gas plants.

The system of gas mixing control selected for best results depends on operating conditions such as the character of the gases to be mixed and the results to be obtained. Proportioning control fits a majority of the mixing requirements.

The availability of gaseous fuels of widely varying chemical and physical characteristics presents new problems in the utilization of these fuels. Because of number and magnitude of the variations in properties of fuels which affect desired thermal effects it may at first appear that each individual burner and each individual kind of fuel must be treated individually for producing the desired combustion effect. Nevertheless, a study of some of the more important combustion characteristics of the different fuels and typical industrial gas burning equipment indicates that a great deal can be accomplished towards reducing, or eliminating most of the difficulties involved in the efficient utilization and distribution of available gaseous fuels.

In practice, it is frequently desirable when designing gas stabilizing equipment to change the flow factor value for the substitute fuel in a manner so that the heat input differs slightly from that of the base fuel supply, to compensate for differences in air requirements of the two fuels, and to compensate for the air in the stabilized gas, when air is used for stabilization. Compensation for differing air requirements is particularly valuable where fuels are used for atmosphere control.

One of the earliest installations of gas stabilizing control is in the East Chicago plant of Youngstown Sheet and Tube Company. A later installation of stabilizing control was made in the Gary tin mill of Carnegie-Illinois Steel Corporation. In the Gary plant the stabilized gas has been found to be preferable in many respects to other gas fuels and it is used wherever it is economically possible. A more recent installation of gas stabilizing control has been made in the Riverside Plant of The Otis Steel Company, Cleveland, Ohio. The Great Lakes Steel Corporation has put in operation in their Detroit plant, a gas mixing control designed to mix coke oven gas blast furnace gas to a constant heating value of 385 Btu. In the Duluth plant of the American Steel and Wire Company, blast furnace gas is enriched with coke oven gas in order to maintain the quality of the mixture constant and improve the performance of a battery of large gas engines in the power plant.

There are many other applications where the mixing of various gases would bring about improvements in the operation of plant equipment. Close control of gas quality and burning characteristic permits closer adjustments on burners and results in gas saving and more uniform heating conditions. Where a substitute fuel is distributed in the same fuel system with another gas it must be stabilized to a value which will make it interchangeable with the base gas in whole or in part.

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Phenolic PLASTICS

By H. F. HORNE

Micarta Division

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

TRAFFORD CITY, PENNA.

▲ THE wide and successful application of laminated bearings in the steel industry has promoted a realization of the unique properties of phenolic plastics in general and led to many new uses. The excellent resistance of this class of products to water, chemicals, and abrasion has resulted in their replacing less satisfactory or more expensive materials, and it is the purpose of this paper to outline briefly some of these newer applications as well as to point out some of the recent improvements in laminated bearings.

PICKLING TANK HOLD-DOWN ROLLS

Because these plastics are little effected by the acid and because it does not scratch or otherwise mar the strip steel, hold-down rolls made of this material are being employed to advantage in pickling tanks. Furthermore, the material has sufficient mechanical strength to withstand severe usage. The roll is made completely sealed to eliminate the possibility of the pickling solution getting to the inside. Therefore, what little chemical reaction does take place affects the roll only on its outer surface.

The rotating bearing surface is an acorn babbitt shell fitted over the plastic shaft end. The roll neck, made of the same phenolic base material, rotates in these bushings and is lubricated only by the pickling solution. The roll is mounted in a large clevis which holds the bearing bushings and spans the length of the roll.

Initial cost of these rolls is approximately the same as the usual rubber-covered steel roll. In addition to giving much longer service, a saving is made in the cost of replacements when surface wear has occurred. With a roll of this type, the surface may be machined and a large tube of the same material pressed over the roll body, whereas a rubber-covered steel roll cannot be so salvaged.

UP-COILER ROLL COVERING

Considerable difficulty has been experienced in the past with upcoiler rolls, following the pickling operations. The fine scratch-free finish necessarily maintained on the steel strip to be used for automobile bodies, refrigerators, etc., precludes the use of metal on many contact and conveying surfaces. The resistance of phenolic base materials to wear and its ability to rotate against metal without abrasion makes it ideally suited for such service.

The first up-coiler roll covered merely consisted of alternate rings of plastic with metal spacers. These rings were cut from laminated gear stock. This procedure was very successful in eliminating scratches, but due to the particular design of this machine and the gauge of steel rolled, the incoming strip rubbed against the carrying roll rotating in the reverse direction. This naturally caused somewhat rapid wear on the plastic, and an auxiliary roll was recommended to correct the condition. Because of the expense involved, the customer was hesitant to make the suggested changes, and we were asked if it would not be possible to furnisha still more wear resisting grade. The regular bearing type material was then molded up in ring form so as to present the same edge construction on the completed roll without loss or waste from the center portion.

The metal spacers were also removed and the entire roll surface covered with the composition rings. After

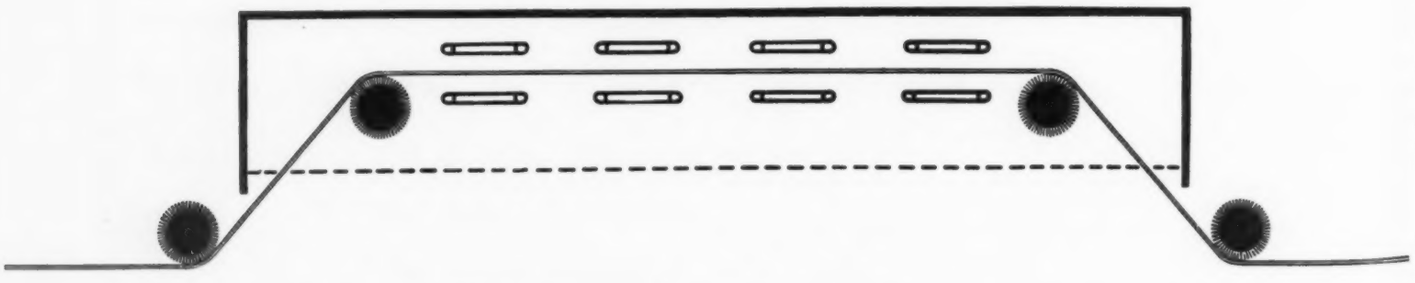


FIGURE 1—Diagram of application of phenolic plastic hold-down rolls in electrolytic pickling line.

TIC APPLICATIONS *in*

he STEEL *Industry*

Presented before the Birmingham District Section of the A. I. & S. E., January 30, 1939

several months' operation, these show practically no wear, and several other up-coilers, both in this and other plants, have been covered with complete success.

BACK-TENSION ROLL AND COIL CRADLE

On the entry side of four-high temper mills, there is normally a fibre covered tension roll, similar to the three roll dray arrangement on cleaning lines. Any marring of the strip surface must be prevented, and a plastic covering has proven much more satisfactory and longer lived than the fibre formerly used.

A similar requirement indicates the use of plastic "on edge" strips for coil cradles. In some cases, curved sections are made, but in most mills, flat boards are so arranged as to approximate the coil curvature.

FIGURE 2—Phenolic base materials are well applied to the covering of up-coiler rolls.

GUIDE BOXES

Preceding each stand of a modern continuous strip mill, a set of guide boxes are placed to put tension on the steel as it passes from one roll to the other. These boxes are frequently made from wood which, under the effect of constant water spray, swells badly and splinters. Any of these splinters passing through the rolls with the steel marks it badly, and may be cause for rejection of the whole coil. The pressure exerted also rapidly wears the softened wood and necessitates its frequent renewal. The ideal material for such use would have good wearing qualities, retain its hardness and resist splintering under repeated water soaking. Also of prime importance, it must be impossible for these guides to mar or scratch the steel in any way. Phenolic base plastic has been very successfully utilized for this service in many mills. Either a special grade constructed with the laminations in the vertical direction, or gear plate of about six inch thickness turned so as to present the grain in the same manner, is used.

Of course, delivery tables on sheet mills involve similar duty; although, as no external pressure is applied, it is not as severe. There are many other places where laminated materials are being quite widely and satisfactorily applied to replace fibre, brass, or other surfaces. These include tables on squaring shears, disc conveyors, skids, and leveler approaches, as well as the other well-known applications of compressor rings, pump valves, and pinion gears.

BEARINGS

Laminated bearings no longer require any introduction to the steel industry, and development work in this line, both in the laboratory and field, has evolved considerable knowledge of the variations in the service requirements of different mills and the particular composition bearing most applicable. In our plastic there have been two general types: (1) the heavy belting base employing a standard phenolic resin, and (2) a comparatively fine weave fabric with an especially modified resin. The latter type, because of its greatly increased wear resistance, has practically supplanted the others, except in applications where very slow peripheral speeds or other factors involving difficult water lubrication are involved. It was thus recognized that if the characteristics of the fine fabric bearing could be made to include some medium to assist boundary lubrication, it would represent a real advance in the art. In all former methods of incorporating these self-lubricating agents, a marked decrease in the lamination bond defeated, for the most part, any benefits obtained. By an entirely new method of impregnation, these difficulties have been overcome, and a bearing produced having extremely long life and applicable for rolling at

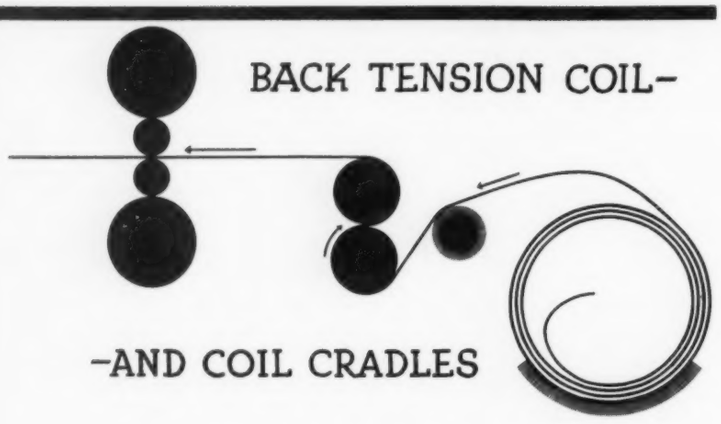


FIGURE 3—Plastic covering on back-tension rolls and coil cradles have proven very satisfactory.

speeds much slower than those previously considered satisfactory for laminated products.

On the finishing stands of a rod mill in the Pittsburgh district bearings of this material have been very successfully used for several years. However, on the first roughing stands, the speeds were as low as 54 feet per minute. Quite rapid wear and occasional overheating prevented the use of any laminated bearing at that time available. On completion of the newer plastic bearing, our first field tests were made by equipping several of the roughing stands in this mill. After six months' continuous service, only relatively small wear has occurred, and the customer is delighted with results. Purely as an experiment, they placed some standard bearings on one or two stands in the bottom position, leaving the new bearings on the top where lubrication is most difficult. All of these standard bearings have since worn out and been removed, and the mill completely equipped with bearings of the new type plastic. Without question, the ability of this bearing to operate under conditions which are not favorable to the maintenance of a continuous water film will allow the use of laminated phenolic bearings in many applications heretofore considered impractical, and markedly improve the life factor on slow speed roughing stands.

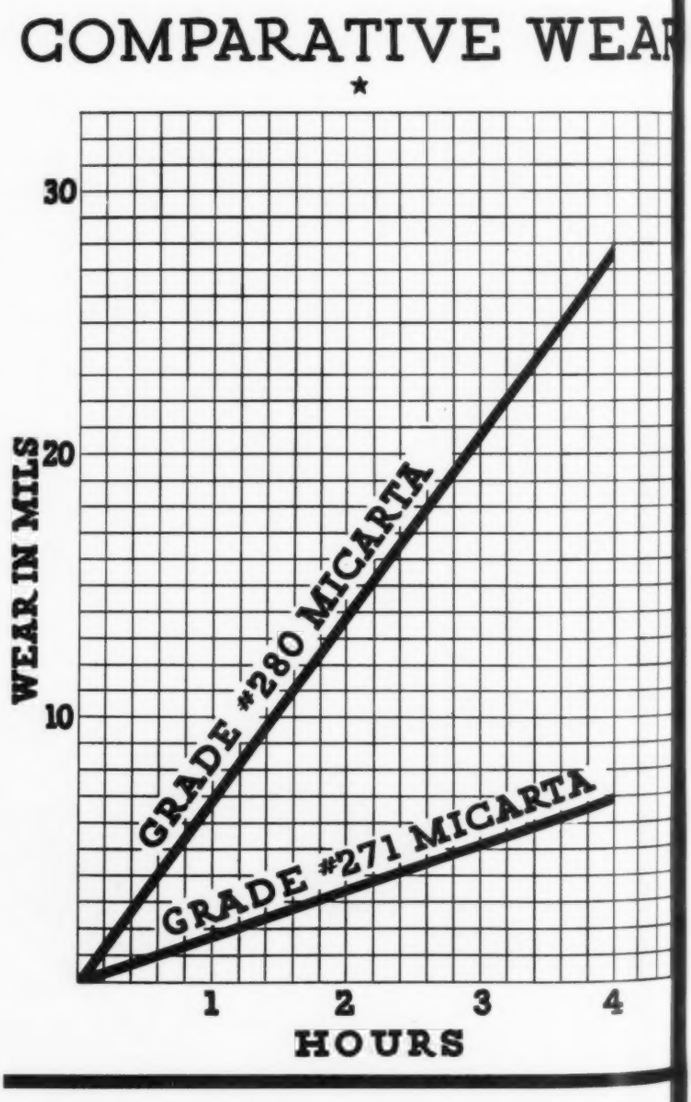
BEARINGS ON TOOL STEEL MILLS, ETC.

Bearings of pinion stands of tool steel or high alloy rolling mills always have been a problem to the operation and maintenance men. These bearings, when worn very little, cause the teeth in the pinion to mesh poorly. The stand becomes noisy and wear is very rapid on the pinion teeth. Combined with the wear in the bearings there is a whip or hammering of the neck on the babbitt linings which causes the latter to flatten out. In normal operation these bearing boxes are replaced with a spare set every four weeks to three months.

Due to the continued success of laminated bearings on the work rolls of many types of rolling mills, it was logical to try them on this troublesome job. As the bearing boxes were solid, the design worked around to a complete 360 degree bushing and a thrust ring. The babbitt was removed, and the rough castings were bored clean on the inside so there would be a smooth backing for the bearing pieces. The bushing was made with a $\frac{1}{32}$ in. clearance for a running fit, and the wall thickness was $\frac{5}{8}$ in. Slots and circular grooves were machined in the castings so that rubber hoses could be inserted. These slots and grooves gave good distribution and circulation of the water. It should be mentioned that normally a complete bushing is not recommended for steel mill applications, unless considerable study is given the problem of getting water to all parts of the working surface. Even then, a top and bottom segment of 90 to 140 degrees is considered more satisfactory. On pinion stands, however, the customer wished to utilize his available solid chucks, so that complete bushings were tried.

Now, what about the life of these bearings? After six months operation, there is only slight wear. Since the

FIGURE 4—Comparative tests show the fine weave fabric type bearing to have much greater wear resistance than the coarse fabric type.



bearings have already outlasted four sets of babbitted bearings, a conservative estimated life for the plastic bearings would be from eighteen months to two years. The problem of keeping water out of the grease used on the pinion teeth was also considered. After several methods had been tried, it was found that by using a heavy black grease, no trouble was experienced. This lubricant is applied every two days and keeps the gear teeth well lubricated.

It may be well to mention the status of laminated phenolic materials employing glass fabric fillers. The advantages of materials theoretically possible with non-cellulose bases and synthetic resins are well recognized, and considerable work is under way in this field. However, there are some technical problems, particularly of adhesion, which remain to be solved before the full advantage of such combinations can be realized. As a matter of fact, there are at the present time several standard grades of phenolic plastic which show lower water absorption, and an acid and temperature resistance equal or superior to any glass fabric base material on the market. Many of the problems remaining to be solved are peculiar to laminated substances, and it is fully appreciated that for certain special motor insulation, etc., the application of glass is well founded. Without question, the problems which are at present proving stumbling blocks will be solved, and a synthetic resin bonded laminated material produced which will have the properties we have every reason to expect are inherent.

In conclusion, it may be helpful to summarize very briefly certain characteristics of laminated materials as compared with rubber, wood fibre, or metal they may replace. First, is the remarkable difference in water absorption showing fibre having 45 per cent absorption in one hour and the laminated material 2 per cent in 24 hours. Laminated materials are approximately one-half the weight of aluminum, and certain grades may be used entirely satisfactorily in non-oxidizing acids in ten per cent concentrations even at elevated temperatures. It will not cut, hammer out, nor gall when properly applied for thrust washers, guides, or bearings. Oil or grease has no effect on the material, whereas these agents deteriorate rubber compounds rapidly. It is stronger, less porous, harder, and machines better than wood. It does not soften under the effect of water, splinter, nor break. Laminated materials and fibre have about the same density, both being considerably higher than wood.

With this unusual combination of properties, it is not surprising to note the new uses to which laminated materials are being placed, and there are, without doubt, hundreds of other as yet untried applications which will be the means of further reducing upkeep and making better steel.

DISCUSSION

PRESENTED BY

D. G. HOLT, Superintendent of Maintenance, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama.

H. F. HORNE, Micarta Division, Westinghouse Electric and Manufacturing Company, Trafford City, Pennsylvania.

A. G. DELANY, Assistant District Manager, Republic Steel Corporation, Gadsden, Alabama.

H. C. KAEFF, Superintendent, Cold Reduction Department, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama.

M. G. CROSTHWAIT, Chief Draftsman, Tennessee Coal, Iron and Railroad Company, Wire Mill, Fairfield, Alabama.

J. E. HARRELL, Chief Electrician, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama.

W. W. GARRETT, JR., Director of Electrical Laboratory, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama.

R. R. THOMAS, Assistant Chief Engineer, Tennessee Coal, Iron and Railroad Company, Ensley, Alabama.

D. G. HOLT: Can you tell us something on the behavior of plastic bearings and coating for the guide rolls in an electrolytic cleaning tank?

H. F. HORNE: Phenolic plastics can be used satisfactorily in non-oxidizing acids in concentrations normally employed. They are not applicable in strongly alkaline solutions due to resin deterioration.

D. G. HOLT: We have several applications of this material, giving very satisfactory results, but I believe it would be difficult to use it on some of the applications you have mentioned. We have composition bearings on some mill roll necks. I do not see how you would use it on a modern pinion stand, where you use a heavy gear tooth lubricant, which might become contaminated from the water used for lubricating the composition bearings. The high tooth pressures make lubrication a difficult problem at best, and the presence of water in the grease might be harmful. We have had babbitt bearings in use over a year, with a good pressure system of lubrication using a leaded compound grease, and I do not believe they have worn ten thousandths of an inch.

H. F. HORNE: With reference to keeping water off of the gear teeth the particular lubricant mentioned in the paper was found very successful and also provided ample lubrication for the gears. Application every two days has been found to be adequate.

MEMBER: What would you consider the maximum temperature of the cool water to get satisfactory results in a rolling mill?

H. F. HORNE: We have tried to set that figure in our minds at about 70 degrees F. From 70 to 80 degrees ought to be absolutely the top limit because we are depending on the water to conduct away all heat which is generated. In other words, if your temperature

differential between the roll neck and the bearing itself is not great enough, the rate of transferring of heat is very much slower and the inevitable result will be a burned bearing.

All of these laminated materials have a very poor thermal conductivity and the improvement of this is one of the problems yet to be solved. If we knew some way to increase the thermal conductivity of this type of material, it would be a great advance. That is true throughout the industry.

A. G. DELANY: We never have had any luck with your fine weave type at all, whereas we have had decided luck with your coarse fabric type, and I am wondering what we are doing wrong.

H. F. HORNE: Do you recognize you have poor water conditions?

A. G. DELANY: According to what you say on your 70 degrees, we have. Our water gets up around 80 and 90 in the summer time and it does carry a little sediment with it.

H. F. HORNE: The experience we have had on the fine fabric as against the coarse fabric type indicates it is invariably a water condition that causes that difference.

I would say that for the last two years 95 per cent of our bearing sales have been of the fine weave grade. The advantages have been so marked that in many cases where it did not work out satisfactorily at first, our engineers pointed out where the water system could be improved, and where the customer has agreed to make those changes, the results have justified our recommendations. In some cases the customer has felt that all that is necessary is to bore some small diameter holes in a pipe. This gives a stream of high velocity water which hits the roll neck and breaks the film that may be formed. One of our competitors has gone a step further and brought out a spray type arrangement which, unquestionably, has certain merit, to prevent this condition. I think a better analysis of the lubricating conditions will show that an ample supply of low velocity cool water relatively free from grit will justify initial cost in longer bearing life obtained.

A. G. DELANY: On a blooming mill, how many tons do you expect to get out of a set of bearings?

H. F. HORNE: I would estimate an average of 500,000 tons in a blooming mill.

A. G. DELANY: That is about what we are running on your coarse fabric type. If the other is a lot better than that I would like to use it.

H. F. HORNE: I wouldn't recommend the fine weave type bearing for a reversing blooming mill. What you are doing, is starting at zero peripheral speed and going to probably 300 feet per minute. Then back again to zero so that you have quite a bit of operation at slow speed. As I pointed out that is a difficulty with the fine weave fabric bearing.

A. G. DELANY: Have you got a new type?

H. F. HORNE: In another type of fine weave fabric carrying some graphite, we have attempted to meet the requirements of low speed operation, and it is very much more satisfactory.

On this mill I spoke of our fine fabric bearing and several competitors' bearings were put in at the speeds of some fifty feet a minute and they all burned out right away. Then we put in bearings containing graphite and these have been operating better than six months.

It hasn't been applied on blooming mills. It is a new development and we have been trying it on some roughing stands. I would not be afraid to apply it on a blooming mill with a customer that realizes we were making an effort to improve the tonnage that could be obtained.

A. G. DELANY: Have you any applications where you use it in sheet mills?

H. F. HORNE: We have a very successful application in the Columbia Steel Works.

A. G. DELANY: No matter how thin a bearing you put in, you have a little bit of resiliency which causes heavy gauge. With the constant pressure we couldn't get the water lubrication. It would break the film before it would get through the bearing. If we got a bearing material tight enough and tough enough and dense enough to withstand the pressure, we would burn the bearing, and if we didn't get one that dense we didn't get the reduction in gauge we expected.

H. F. HORNE: The gauge problem does complicate it. In general as thin a radial section is used as practical where accurate gauge is a problem. This is common practice in rolling alloy steels for knife stock, etc.

I might mention our attempt to solve the three high sheet mill was the combination of the fine fabric type backed up with about 40 per cent of the heavy bearing. The difficulty in this type of mill particularly was that the pounding action of the mill would tend to fracture the entire bearing, so that we needed something in the back that would have a little more resiliency to act as a buffer and shock absorber. It has worked out very well.

H. C. KAEFF: Have phenolic plastics been used in an electrolytic cleaner with a caustic solution?

H. F. HORNE: No. No phenolic type material can be used satisfactorily in caustic solution. The reaction of laminated materials in general to acids and alkalis is this: In the case of acids we have to get the concentrations high enough to attack the fabric before we get deterioration in non-oxidizing types, whereas, in caustic, any alkaline solution will soften the resin itself, thus a two or three per cent caustic solution will attack the resin and release the bond and allow de-lamination.

M. G. CROSTHWAIT: I would like to ask a question on the application of composition bearings to rod mills, for instance, down here at Fairfield we have rubbing speeds of say about 120 feet minimum up to 1500 feet on the finishing stands.

What do you consider the lower limit for application, say, on the roughing end of a rod mill?

H. F. HORNE: With this newer type bearing, incorporating some lubricating agent, I wouldn't be

afraid to apply them at forty feet per minute. We have never tested it lower than that. Some of the users have been less afraid, going back to roughing stands, to install them at lower speeds than we have been willing to recommend. I wouldn't be afraid to risk forty feet per minute.

M. G. CROSTHWAIT: We have gone as low as 160 and to go clear back to number one stand, we will have to go to 120 ft. per min.

H. F. HORNE: There is no doubt but what the fine weave fabric bearing will do that. I might point out that, in developing this type bearing, it was in a rod mill where the first experiments were made. In our laboratory we got so much greater wear resistance on this material, it was really phenomenal. We were a little bit afraid of it. We went into the rod mill of the Jones and Laughlin Steel Corporation. We said, "Here is a bearing we think is pretty good; we don't know. Are you willing to try it?" They said, "Yes. We have been using your bearing and several others and we have been getting about 20,000 tons". The best they had obtained on metal was 5,000 tons. They put it in and that bearing ran 95,000 tons before it was renewed, and since that time—that has been about five years ago—the average on this rod mill on this bearing has been around 85,000 or 86,000 tons.

J. E. HARRELL: Just how far have you gone with putting graphite in the material used for bearings?

H. F. HORNE: That rather puts me on the spot a little bit, because I don't like to say too much about graphite. Graphite is one of the materials that can be used to obtain this self-lubricating material to aid in boundary lubrication. Graphite is one of the constituent materials in this bearing. The use of graphite has always been somewhat of a troublesome problem. If you examine flake graphite you will notice it is very slippery, and the difficulty has been to get the phenolic material to stick to the graphite. If we would get graphite in the bearing we might obtain certain properties, but it had poor bond strength between layers and defeated our purpose. A method has been developed and patented whereby the graphite is incorporated before the resinous material is added. In that way we get a high bond strength in a material containing a good percentage of graphite, and so have the advantages of graphite without the disadvantages that have always been inherent.

W. W. GARRETT: We are interested in knowing, before we install these bearings, how much friction reduction we can get. My question is where would I expect to get the most reduction in friction, on the high speeds or the low speeds?

H. F. HORNE: Can you give me an idea of what the high speeds and low speeds are?

W. W. GARRETT: We will say from 200 for the low speeds to 500 or 600—three to one.

H. F. HORNE: In that range you would get much greater reduction in friction at the higher speeds.

W. W. GARRETT: At the higher speeds?

H. F. HORNE: The frictional curve is fairly flat from above 100 feet to around 600 ft. per min. and then it starts to go up. Above 700 feet the curve goes up rather rapidly.

W. W. GARRETT: Then you would say the higher the speed the greater the reduction in friction?

H. F. HORNE: Up to about 600 feet. From about 100 feet to about 700 feet we can retain the water film. After we get to higher speeds apparently the film starts to break down due to centrifugal force. At the lower speeds it will not be obtained because the shaft does not have enough speed to carry the film and maintain it on the bearing surface.

J. E. HARRELL: Have there been any tests made in your laboratories comparing oil lubricant with water for friction tests?

H. F. HORNE: It is rather curious. I just spoke a moment ago about the curve for friction with water lubrication going up quite rapidly below 100 feet per minute. However, with oil we get a marked decrease in the friction. We are not talking quite the same language here because with oil we can't get into the range of pressures you are operating in steel mills. We don't recommend oil for pressure above 80 pounds per square inch. We are not able to get enough heat conducted by the oil to run bearings up to those higher pressures, but at low pressure and low speeds the oil film will be maintained much better than the water film.

R. R. THOMAS: I have been expecting to hear someone bring up the question as to the causes of some of the failures on installations of non-metallic bearings. There are several important factors involved in the application and operation of this type of bearing that must be given the proper attention if a satisfactory performance is to be obtained.

The greatest difficulties are usually encountered on initial installations of non-metallic bearings on old mills where metallic bearings have been previously used. This is due mostly to the unfamiliarity of the mill operators with the difference in the characteristics and requirements of the two types of bearings.

Some of the essential requirements, which, if neglected, may result in bearing failure are: smooth surface of roll necks or journals, design of chocks or bearing supports that provide rigid backing for the bearing, accurate mill and bearing alignment, and proper application and ample supply of suitable water.

Another source of trouble often encountered on new installations is that of thrust collars, especially on mills where considerable lateral thrust is developed. Lots of grief is often experienced before it is learned how to maintain the proper adjustment.

Also in some cases it has been found quite beneficial in reducing thrust loads by improving the alignment of drive spindles, such as providing proper carriers and reducing the clearance between the pods on the spindles and coupling boxes.

H. F. HORNE: The points mentioned are certainly very pertinent to the successful application of any laminated bearing. There is no question but that the lami-

(Please turn to page 81)

Comments on S
BLAST FURNACE P
and some of it Pe

By J. E. URQUHART, General Superintende
WOODWARD IRON COMPANY
WOODWARD, ALABAMA

▲THE southern pig iron producing district centers in Birmingham and immediately adjacent territory. This section of Alabama was endowed by nature most generously, in that the iron ore, limestone and coal deposits lie almost literally side by side.

Two of the iron producers in the Birmingham district have their own railroads, the terminals of which are the ore mines at one end and coal mines at the other, with the blast furnaces and coke plants in between, the total distance from one end of the railroad to the other being not over sixteen miles. The proximity of the coal and ore mines together with the mild climatic conditions, which is a situation occurring nowhere else in this country, has resulted in the one outstanding difference in practice between the southern and northern plants in that it is unnecessary to build up large inventories of raw materials for use in winter months. We have no ore bridges, no car dumpers, no transfer cars, no stocking and reclaiming facilities for ore or coal as a fixed part of the plant equipment, and the only necessity for inventories of raw materials has been to take care of emergencies such as labor disputes, which have been more frequently recurring, especially with the coal mines. Normally, however, the ore is delivered directly to the stock house bins from the cars loaded at the mines.

To anyone accustomed to carry large inventories of ore, stone and coal, and who has to contend with the operating difficulties resulting from frozen material, the operating and maintenance expense of costly car dumpers, ore bridges, transfer cars, etc., this sounds like an ideal situation. Its ideal features, however, are offset to a certain extent when consideration is given to the character of the ores with which the South deals. We have the brown ores, or limonites, which are used to some extent by all the iron producers, but the deposits are now limited in tonnage and some so irregular in size and analysis as to be of minor importance in consideration of its effect on furnace practice or pig iron production.

The ore which is the back bone of the southern iron producers is, of course, the hematite, or hard red ore, of which the Red Mountain area contains large deposits, estimated to last at its present rate of extraction over 100 years. This ore varies in analysis from the west end of the mountain to the east, the iron content varying from 32 to 40 per cent, and the silica content from 11 to 22 per cent, with lime content varying from 10 to 19 per cent. An individual mine will run very consistent in analysis, but the lime content decreases rapidly going from west to east, so that at one end we have an ore containing more than enough lime for flux, while at the other end the ore is so siliceous that considerable stone would be required to flux it. To a company obtaining all its ore from one mine the problem of uniformity is not one of great concern, but to a large company producing ore from seven or eight different mines the variation in analyses presents a problem of ore mixing or the carrying of an excess lime content in the slag to compensate for fluctuating silica content of the ores. This lean ore with which the southern furnaces deal means very large slag volumes to handle, from 1900 to 2100 pounds per ton, the average running in the neighborhood of 2000 pounds. This compares with 1000 to 1200 pounds in the North, and largely accounts for the very much higher coke consumption to which we are accustomed. However, the large slag volumes are not solely responsible for high coke consumption or some of the other inefficiencies existing in southern blast furnace practice as a whole. The southern furnace operators have been very backward in making advances and improvements in general that would result in more efficient practice. This is easily explained by the fact that up until very recent years labor has been so cheap and raw materials were delivered to the furnaces at such low cost that there was not the incentive to make capital expenditures to save labor or coke consumption. As the differential between northern and southern labor rates has become smaller and smaller, there has not only been an incentive but it has become an economic necessity that the southern

Proximity of coal, ore and limestone deposits naturally resulted in centering of pig iron production in the Birmingham area.

SOUTHERN PRACTICE

Peculiarities

Presented before A. I. & S. E. Annual Spring Conference
Birmingham, Ala., March 27-28, 1939

plants be modernized to bring them to the same degree of relative efficiency as the plants in the North, which are favored by richer ores, lower slag volumes, and more favorable freight rates.

Among the things of which the South has been extremely slow in realizing the potential value should be classed, as the most important, the failure to prepare the ore for charging. Up until very recently the ore from the mines was put through a primary crusher set at an opening of about 3½ in. to 4 in., and the resultant product charged to the furnace without further preparation. One of the plants in the South some years ago brought ore from the mines and crushed it in a makeshift crusher and charged the finely crushed ore as an experiment. The results in the furnace of the more finely crushed ore were either negative due to the short duration of the test or they were lost sight of due to the over-shadowing interest in the merits of equipment to clean the furnace gas. In 1929, one company made the first move in starting to close up on the crusher and to produce ore of smaller size. This was then followed by a separation of ore into two sizes, called coarse and fines. The fines were the ore passing through ¾ in. screen, and the coarse everything above, with pieces ranging up to 5 or 6 inches in one dimension and possibly one or two inches in thickness. The Woodward Iron Company in 1934 installed an ore screening plant which included a secondary crusher, enabling production of much smaller ore, originally in two sizes, coarse and fine. This was expanded a little later and another screen installed, making it possible to separate the ore into three sizes, coarse, medium and fine, which is the separation at present. The fine ore is the portion passing through ⅜ inch screen and has about the following screen test:

On 10 mesh	31.5 per cent
On 20 mesh	24.4 per cent
On 40 mesh	28.5 per cent
Through 40 mesh	15.6 per cent

The medium ore is what passes through a 1¼ inch screen and remains on ⅜ inch and has approximately the following screen test:

On 1 inch	18 per cent
On ¾ inch	20 per cent
On ⅝ inch	31 per cent
On ¼ inch	20 per cent
Through ¼ inch	11 per cent

The coarse ore is governed on top size by the crusher setting, which is about 2½ inches, and the bottom size by the 1¼ inch screen. It has the following screen test:

On 2 inch	10 per cent
On 1½ inch	32 per cent
On 1 inch	54 per cent
Through 1 inch	4 per cent

The sizes are normally produced in the following proportions: coarse, 42 per cent; medium, 38 per cent; and fines, 20 per cent. Unfortunately the secondary crusher which was installed was a piece of idle equipment and was of insufficient capacity to take the entire ore requirements of the furnaces without a rather wide setting so that it was impossible to get the sizes down as low as seemed desirable. However, it was enough to be thoroughly convincing that much more efficient smelting of ore was entirely possible. The difficulties encountered in the furnaces will be discussed in detail in another section of this paper.

In the meantime one of the producers had gone to finer ore preparation and went one step further than any one else had yet gone by erecting a sintering plant in which the fine ore was sintered with flue dust, resulting in a beneficiation of their very fine ore as well as utilizing an enormous mountain of flue dust which had been the accumulation of a good many years. It is believed the results of this operation have been more

J. E. URQUHART

than satisfactory and fully justified the soundness of judgment in making the installation. It might be added, however, at this point, that the problem of flue dust, of which mention will be made later, has changed and will probably continue to do so, consequently it may be very much of an economic question whether such an installation would be justified if the current production of flue dust were the only source of supply.

The results of this preliminary move on ore preparation were so encouraging, even though accompanied by certain unexplained furnace difficulties, that the Woodward Iron Company decided to undertake a rather extensive program of research on red ore, having in mind three main objectives: first, the improvement in quality of pig iron; second, more efficient furnace practice; third, elimination of furnace irregularities generally prevalent in southern practice.

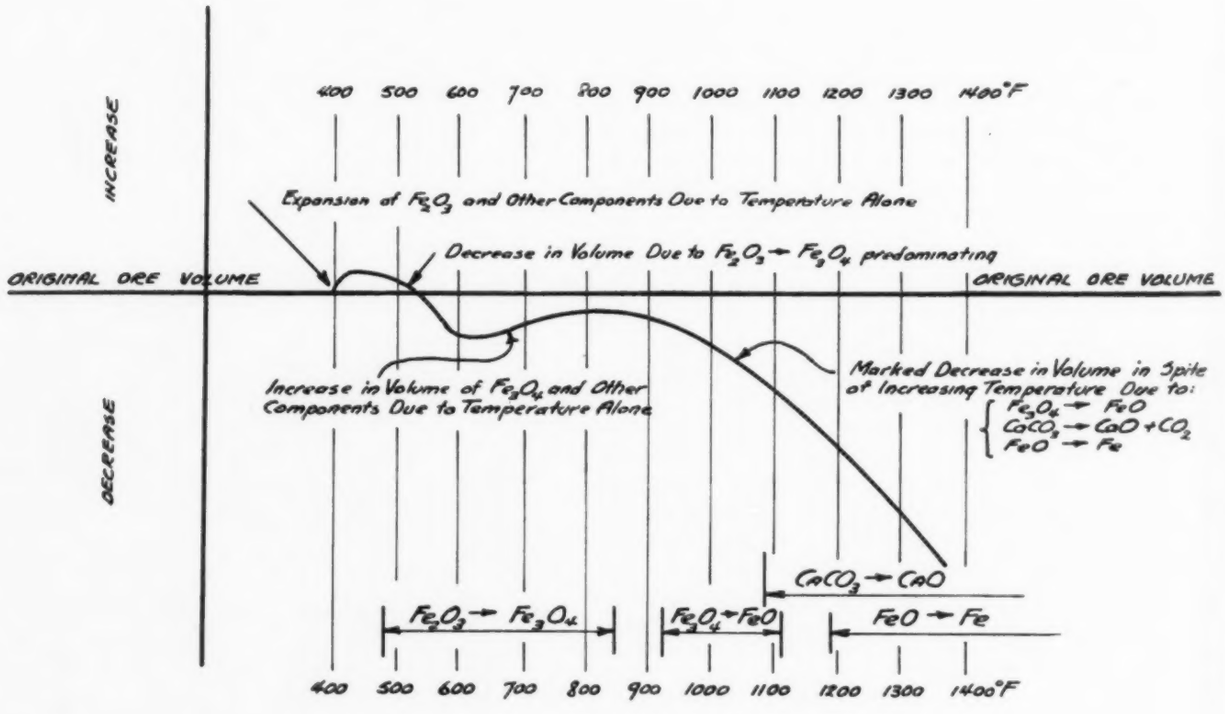
These tests extended over two years and covered thousands of samples of accurately prepared sizes of ore experimentally subjected to atmospheres of blast furnace gas under various temperatures and pressures. Consideration must be given the fact that it is not intended to convey the impression that these tests are actual duplicates of furnace conditions, but all tests were so conducted that it is felt that the results can be interpreted as being highly indicative.

The first important indication was that there was no appreciable swelling of the ore. Between the temperatures of 400 and 500 degrees there was a slight expansion due to temperatures alone, but this increase in volume was very quickly offset by indirect reduction taking place, causing a rather rapid decrease in volume which proceeded until the Fe_2O_3 was reduced to Fe_3O_4. Once this reaction was complete, it appeared that there then occurred expansion due to temperature but even then the magnitude of the original ore volume was not attained. At about 900 degrees F. considerable further reductions in volume began to take place due to reduction of Fe_3O_4 to FeO, calcination of the $CaCO_3$ to CaO and final reduction of FeO to Fe. This shrinkage continued to increase until temperatures in neighborhood of 1500 degrees F. were reached and at that temperature amounted to approximately 20 per cent. This volumetric change is shown in Figure 1.

Secondly, calcination of the calcite component began slightly under 1100 degrees F. and the temperature at which completion of this reaction took place was largely governed by the size of the pieces and the pressure in the furnace.

Thirdly, it was found that a piece of red ore 1 inch in thickness differed very little in its degree of reducibility to metallic iron from that attained by ore crushed to $\frac{1}{8}$ inch in size by the time 2200 degrees F. was reached in the furnace. However, in temperature zones of from 1100 degrees F. to 1600 degrees F. in the furnace there was very little indirect reduction accomplished by the CO. For instance, at a temperature of 1700

FIGURE 1—Graphical representation of volume changes believed to take place in ore with varying temperatures.


400 500 600 700 800 900 1000 1100 1200 1300 1400°F
INCREASE
Expansion of Fe_2O_3 and Other Components Due to Temperature Alone
Decrease in Volume Due to $Fe_2O_3 \rightarrow Fe_3O_4$ predominating
ORIGINAL ORE VOLUME
ORIGINAL ORE VOLUME
Increase in Volume of Fe_3O_4 and Other Components Due to Temperature Alone
Marked Decrease in Volume in Spite of Increasing Temperature Due to:
$Fe_2O_4 \rightarrow FeO$
$CaCO_3 \rightarrow CaO + CO_2$
$FeO \rightarrow Fe$
DECREASE
$CaCO_3 \rightarrow CaO$
$Fe_2O_3 \rightarrow Fe_3O_4$
$Fe_3O_4 \rightarrow FeO$
$FeO \rightarrow Fe$
400 500 600 700 800 900 1000 1100 1200 1300 1400°F

PER CENT CONVERSION OF IRON CONTENT TO

degrees F. one inch spherical pieces of ore showed less than 10 per cent reduction to metallic iron, while ⅛ inch spheres subjected to the same conditions showed a reduction to metallic iron of about 65 per cent. These results are shown graphically in Figure 2.

Fourthly, the slight reduction that took place in the ore between temperatures of 1100 degrees F. and 1600 degrees F. was probably due to the calcination of the $CaCO_3$ component and while the liberation of the CO_2 was taking place the ore lump was surrounded by a gaseous jacket of CO_2 which stopped or greatly retarded the contact between the iron oxides and the CO gas.

Fifthly, the CO_2 liberated by the calcination of the calcite of the ore is of little value, and is probably of detriment to the coke efficiency, since it is liberated at temperatures still high enough in the furnace to react with the coke to form CO, which when formed is so high in the furnace that it has little opportunity to reduce the basic ore but can only rise and leave the furnace as a wasted reducing agent.

The results indicated by these tests, as well as the actual practical results obtained in several furnaces from a reduced ore size, led to the general conclusion by furnace men in the district that very decided improvements in efficiency might be obtained by improved sizing, and a very conclusive test was run by one furnace plant using carefully prepared and sized ores. The test extended over a 90-day period and, with the exception of the ore, all other conditions were kept as constant as possible. Variations beyond control affected the test, however, one important one being the moisture content, for the period averaging 7.72, which is decidedly above the average and of course was detrimental to the best results. The ore was charged by grades according to the rate at which it was produced, viz: 47 per cent coarse; 27 per cent medium and 26 per cent fines. The screen analyses were as follows:

	Per cent on screen
Coarse	
On 2 inch	1.2
On 1¾ inch	1.4
On 1½ inch	4.2
On 1 inch	26.4
On ¾ inch	27.2
On ½ inch	23.5
On ¼ inch	3.2
Through ¼ inch	1.8
	Per cent on screen
Medium	
On ½ inch	12.6
On ¼ inch	28.4
Minus ¼ inch	59.0
	Per cent on screen
Fines	
On 6 mesh	2.26

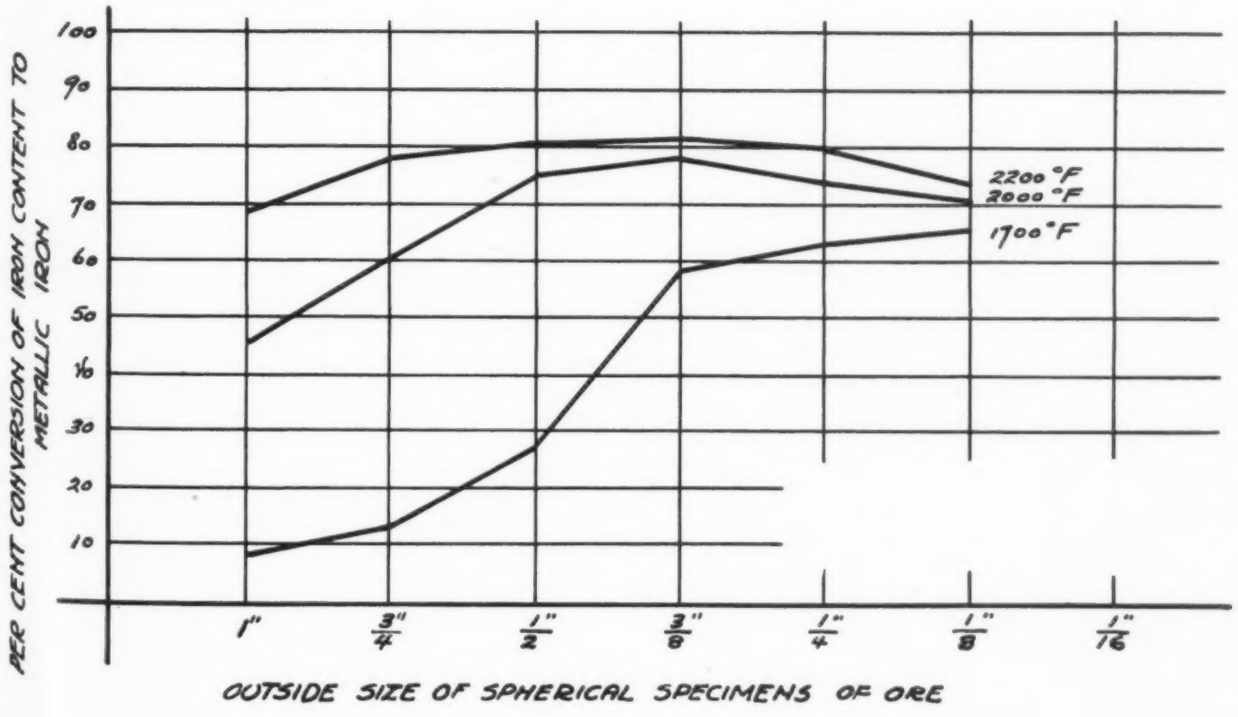


FIGURE 2—Graphical presentation of indirect reduction characteristics of red ore under blast furnace conditions.

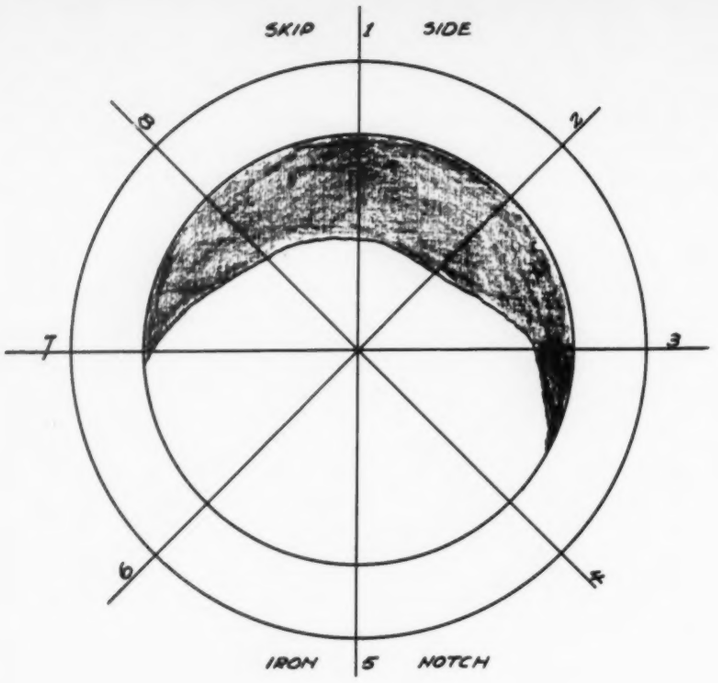


FIGURE 3—Plan view of crust formation on blast furnace wall at an elevation of 54 ft. above the tuyeres.

On 8 mesh	8.33
On 10 mesh	8.48
On 14 mesh	11.33
On 20 mesh	12.57
On 28 mesh	11.26
On 35 mesh	11.11
On 48 mesh	8.77
On 65 mesh	6.87
On 100 mesh	4.97
On 150 mesh	3.66
On 200 mesh	3.95
Minus 200 mesh	6.44

The screen analysis of the total product showed that approximately 79 per cent was smaller than 1 inch in size. This compares with the normal ore which is crushed in a crusher having a 2-inch opening and the resultant product charged without screening or further preparation. Such an ore would have a larger percentage above 2 inches in size and would have many pieces 2 inches or higher in thickness, ranging up to 8 inches to 10 inches in length or width. However, the fines in this mixture would be smaller in quantity and not as fine.

The results accomplished for this test run were most convincing and, as compared to practice generally accepted, amazing. The burden ratio was increased from about 2.20 at the beginning of the test until a maximum was reached of 3, one test month averaging 2.93. The coke consumption was lowered from about 2500 pounds per ton to 2099 pounds, and one month had an average of 1982 pounds. The savings for the entire test period amounted to 450 pounds of coke per ton of iron, with a 14 per cent increase in tonnage produced as compared to the actual practice for the year 1937. Consideration must also be given the fact that when this test was started the moisture of the blast was running about 5 grains, averaging 5.75 for the first 15-day test period. From there on the moisture contest rose steadily for two months, averaging 7.29 for the next month and 8.93 for the following month, with peak days going as high as 12 grains and averaging 7.72 for the entire test period.

Of course, with the burdens carried and the finer ores used, the furnace worked under considerably higher pressure, lower top gas temperatures and greatly improved gas quality. The CO/CO_2 ratio before the test was started averaged well over 3, with a Btu. value of approximately 112. During the test the ratio of CO to CO_2 dropped as low as 1.89 and averaged somewhat over 2. The Btu. value of the gas dropped as low as 94 and averaged a little over 100.

This test, carried out on a more extensive scale than any of the previous ones, simply confirmed the results already indicated by other furnaces operating with fine ores, but which had not carried the degree of fineness as far.

As a consequence of results indicated by experimental work and attained in actual practice, the Woodward Iron Company has purchased a large crusher which will make it possible to crush all ore to 1 inch in size or lower and it is the intention, upon completion of this installation, to eliminate entirely the coarse size which now approximates 45 to 50 per cent of total production.

The next most important raw material, viz: coke, had been neglected equally as badly as the ore as far as preparation is concerned. The coals used by the blast furnace coke producers consists mainly of the following: Mary Lee, Pratt and American seams. All require washing and have the following proximate analyses after preparation:

	Mary Lee	American	Pratt
Volatile matter	28 to 30	29 to 31	26.5 to 27.5
Fixed carbon	58 to 61	58 to 60	65 to 66
Ash	8 to 9	5 to 7	7 to 7.50
Sulphur	.75	1.0 to 1.1	1.0 to 1.1

None of the coals were pulverized until very recent years. when the Sloss-Sheffield Company installed a crusher primarily for the purpose of preparing coal for the production of foundry coke. The effect of pulverization on the coke was so marked that they then started to pulverize the coal for furnace coke. This was followed by the installation of a pulverizer at Republic and then at Woodward. The coal is generally pulverized to 78 per cent through $\frac{1}{8}$ inch screen. The effect on the coke of pulverized coal is indicated by the following comparison: a tumbler barrel test conducted aecording to the ASTM method showed an increase of 10 points in the stability factor, which is what remains on a 1 inch screen. The hardness factor, which is what remains on $\frac{1}{4}$ inch screen, was also raised 10 points. Breeze production was reduced by approximately 20 per cent.

It was common practice to screen the coke over a $\frac{3}{4}$ inch screen, or smaller, and remove the breeze, which was the only preparation the coke received. There were no coke crushers to break down the larger pieces and no attempt was made to separate the nut from the furnace coke. Consequently, the range in size varied

from a piece that would just stay on a ¾ inch screen to pieces 6 or 8 inches thick and one-half the width of the oven.

One plant in the district still delivers its coke to the furnaces with the only preparation being the removal of breeze. It is now the general practice, however, to pass the furnace coke through a roll spike-tooth crusher set at 2½ to 3 inches to break down the oversize. The coke is then screened over either roll grizzly or shaker screens having 1½ inch square openings. This produces the furnace coke proper. The coke which passes through the 1½ inch screen and remains on a 1 inch screen is loaded out separately as nut coke, and when insufficient market exists to dispose of this product as domestic coke, it is charged in the furnace. It is charged by itself, however, in the proportion necessary to dispose of the surplus. The Woodward Iron Company uses from 20 to 25 per cent fairly regularly without any apparent ill effects on the furnace operation. It is interesting to note that during a strike it was necessary to conserve our stocks of coke as much as possible and one furnace was operated for quite some time on 50 per cent nut coke without difficulty.

No plant in the southern district has up to the present done anything toward screening the coke at the furnace bins. The Woodward Iron Company is now putting in coke screens at the bins, which will be the first installation of its kind in the district. The coke from the screens will be delivered to weigh hoppers and from there to skips.

A pecularity of the coals with which we deal is that when the coking time gets much faster than .75 of an inch per hour the furnaces begin to lose burden rather rapidly. It has been found that from 23 to 25 hours seems to be the most favorable coking time, and when the coking time drops to 17 to 18 hours, it is necessary to unload the furnaces at once. This is in spite of the fact that all the tests on coke do not show radical changes that would forecast a loss of burden which may amount to as much as 10 per cent on the extreme ranges of coking time.

It was on this account that the Woodward Iron Company made a major repair to one block of their coke ovens during 1937 in order to make possible a coking time of at least 23 hours*. It is believed that all furnace operators in the district have had the same experience whether using the Mary Lee, Pratt or American seams of coal.

With the exception of the Tennessee Coal, Iron and Railroad Company, all of the furnaces in the district are small, two of them having only 12 ft. 2 in. hearths. The others range from 15 ft. hearths to 17 ft. 6 in. The Tennessee Company has four furnaces with hearth diameters ranging from 21 ft. to 23 ft. and the others ranging from 13 ft. 6 inches to 19 ft. 6 in.

The principal changes in recent years in furnace design have tended toward increased stock line diameter and increased furnace height, with a bosh angle of about 80 degrees, or slightly higher. These are only natural developments resulting from ore poorly prepared and therefore hard to reduce, from very high flue dust losses, and failure of the furnaces to be free moving.

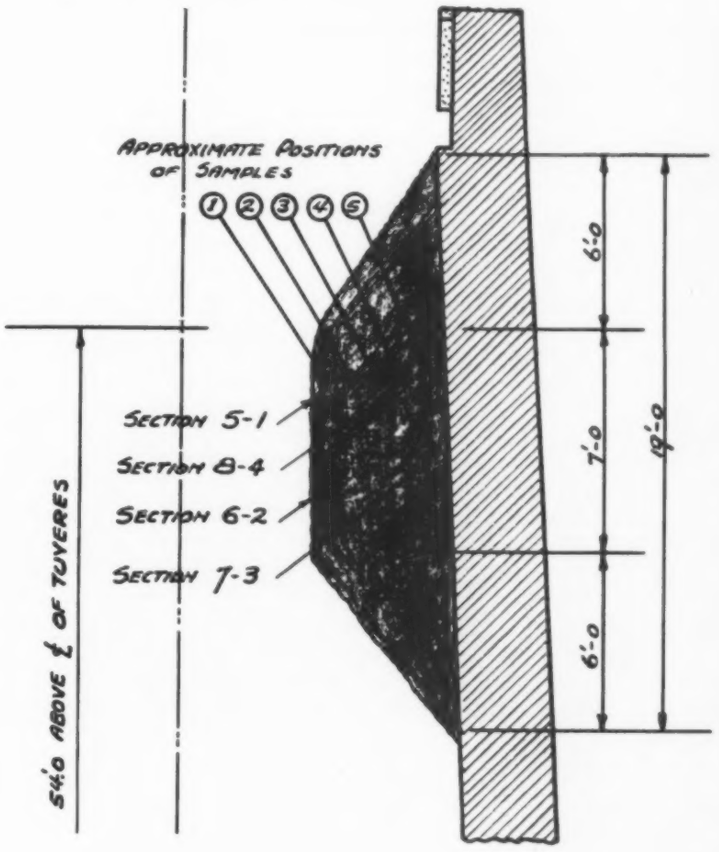
The operation of the furnace proper with the changed sizes of red ore and the greatly increased quantities of fine ore at first was not without its difficulties. The experience of all the operators was similar in almost every respect. The three sizes of ore were charged by themselves in the proportion produced, approximately 45 to 50 per cent coarse, 25 to 30 per cent medium and 20 to 25 per cent fines. The standard method of charging was three ores, then three cokes on the bell, and dump. One of the plants has a spiral method of charging which theoretically keeps coke against the walls at all times but even with this method some of the difficulties encountered by the others were also experienced.

The difficulty first encountered was a rising blast pressure which was at the same time very irregular. This might be felt in a comparatively few days or it might not occur for a month, but in every case the final results were the same, high and irregular pressures, furnace hard to move, blow-throughs with its resultant high flue dust production and, what was of greater importance to the merchant pig iron producers, iron off grade from the narrow specifications permitted. Under these circumstances the only alternative seemed to be to take off all the fine ore, or at least greatly reduce it, replacing with coarse material and the furnace would soon straighten itself out in every respect.

In an attempt to overcome this, various methods of charging were tried and a standard practice of reversing the filling regularly 33⅓ per cent of the time was set up. This practice applies particularly to the Woodward Iron Company when using 100 per cent red ore with only enough tailings or other siliceous material to flux. Using this method it has been possible to carry indefinitely very high percentages of fine ore and to run for

*"Rehabilitation of a Battery of Vertical Flue Coke Ovens", E. R. Merrill, IRON AND STEEL ENGINEER, JULY, 1939.

FIGURE 4—Elevation of crust formation of Figure 3, showing outlines on various segmental sections.

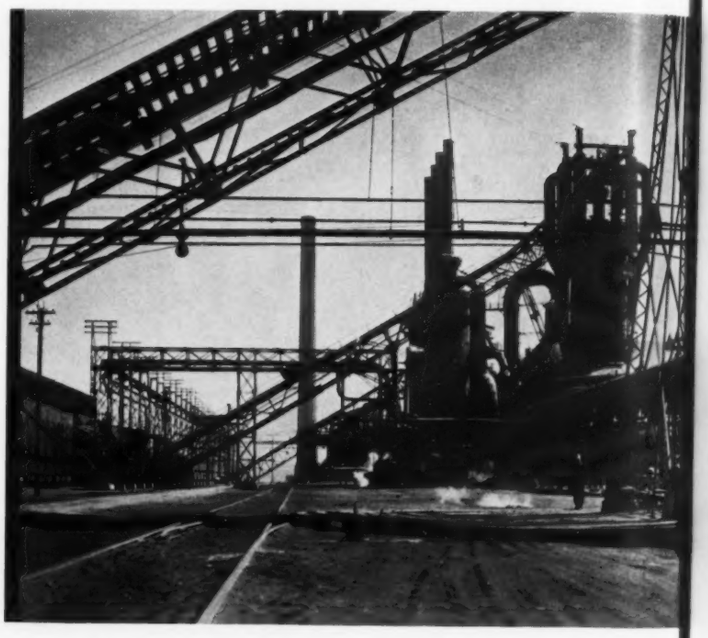


indefinite periods with from 70 to 75 per cent of the burden under 1 inch in size.

The merchant furnaces are not in the same situation as those furnaces producing basic almost entirely, as their problems are multiplied by the constant necessity of changing burdens to meet the specifications of customers, changing silicons from as high as 4 per cent to basic in very short periods. As a result of these rapid changes in silicon the melting zones in the furnaces are constantly being raised and lowered, which in itself adds complications to the operators' problems. This, together with the fact that our red ore contains important amounts of low fusion alkalis, makes it very important that charging and distribution of gases be maintained as uniformly as possible to avoid deposition of "scabs". Tests on our ore show that at times the alkalis, consisting of oxides of sodium and potassium combined, may run as high as 1.29 per cent, with the average approximately .7 per cent. This means that in a furnace using red ore almost entirely, 13,000 to 14,000 pounds of these oxides are charged each day, of which normally 95 to 98 per cent is eliminated in the slag. We can only theorize as to what actually happens in the furnace with these alkalis, and what part they play in the formation of incrustations on the furnace walls, generally in the upper part. The fact remains, however, that all of the merchant furnaces have had these scab formations and it is believed that all have been of very similar nature. A picture of a typical scab is shown Figures 3 and 4. It is believed that the alkali component of the materials charged in the furnace undergoes volatilization in the course of descent in the furnace, and, because of the size of the lumps of material, that fairly high temperatures must be encountered before this evolution is complete. This volatilized alkali rising with the blast reaches low enough temperatures to condense out on the colder stock up in the furnace and again descends, thus building up a concentration of considerable magnitude in the lower part of the furnace. This is proceeding at temperatures when the silica, alumina, and lime are uniting to form compounds, while at the same time silicon and alumina are also uniting with the alkalis. It is believed that small particles containing essentially lime, silica and alumina, having reached a zone in the furnace where they have attained union, and being in an atmosphere high in volatilized alkali, absorb the readily reacting alkali, bringing their surfaces to considerable fluidity. Rising in the blast, they settle out on bodies against which they are thrown and whose temperatures are such as to be bondable with particles having the lower melting point and sticky surfaces of high alkali content. By far the greater number of particles adhere to stock which in due course descends, carrying with it the attached alkali particles and bringing them to zones where union with additional lime, silica and alumina, which are in preponderance, thickens and stiffens the otherwise fluid alkali coating of the particles. These particles then descend, are fixed into compounds and carried through the highest temperatures and out with the slag.

An analysis of the binding component of a scab shows alkali content ranging from 10 to 21 per cent. It is also believed that this scab formation will not occur when making basic iron entirely, but is much more apt to occur on a furnace changing from low to high silicon and back again to low.

One theory advanced on this problem was that, due to the steep angle of repose of the fine ore, too high a proportion of fines was against the walls, making this area more or less dead, or at least a zone of greatly reduced activity. It was therefore reasoned that with fine ores the ratio of stock line to bell diameter was not correct and that a smaller bell should be used to throw more fines to the center of the furnace. This was tried and a 7 ft. 6 inch bell put in on a 16 ft. 6 inch stock line, but it is believed that the results have been negative, and the ratio of bell diameter to stock line may still be a disputed question. It is felt that some-



Modernization of southern blast furnaces, which has progressed slowly due to low costs of various items of production, is now going forward.

what the same results may be accomplished with a conventional bell and stock line ratio, by charging the individual sizes in separate layers of sufficient size to throw a large percentage of fine material to the center of the furnace. It is believed that with the proper preparation of ore and coke, and with proper methods of charging to insure the uniform flow of gases through the stock column, the difficulties with scab formations will be eliminated.

Another peculiarity of the southern furnaces is their failure to move themselves regularly. Without exception all of the furnaces in this district require checking, especially when on basic iron. When using a high percentage of brown ore in the burden, and on foundry iron, there may be free moving periods, but it is the generally accepted practice even on foundry iron to lower the blast pressure every 25 or 30 minutes to allow the stock to settle. G. M. Harris, superintendent of blast furnaces at the Tennessee Company, in a paper

presented some time ago made some very interesting comments on this subject. He stated that in his experience he had found it necessary to move the furnace regularly under two particular conditions: (1) when producing basic or low silicon iron, and (2) when hearth diameter exceeds approximately 14 feet. Inasmuch as his comments on this are very interesting direct quotation is made:

"Over a period of years I have observed these operating peculiarities of small versus large furnaces in the South, as regards this condition, and during the period as an operator I have never known it necessary to adopt, as a phase of practice, the force movement of a small furnace. Without exception to my knowledge, they travel freely on a blast pressure of from 12 to 16 pounds, and produce a good grade of foundry iron and basic iron under favorable coke rate and tonnage conditions. As a contrast, to enlarge such a furnace in excess of 14 ft. in hearth diameter, maintaining other proportionate angles, volume and dimensions, it becomes an operating necessity to move them even though no changes in raw materials have taken place. I have only one theory to advance in this connection, that being that usually with an enlarged hearth we engineer and provide an increased height of stack. By so-doing we automatically increase stock column pressure which is excessive to the extent that the buoyancy of ascending blast volume and gases cannot counteract."

This subject is one which may be argued at great length by blast furnace operators but my conception as to the failure of the furnace to be free moving is somewhat at variance with Mr. Harris' conception.

I would advance the theory that, on account of the large volumes of slag with which we deal and on account of the difficulty in reducing the red ore, especially the large sizes, we have a sticky viscous agglomeration in the upper part of the bosh. Due to the iron oxides reaching the upper part of the bosh in an unreduced condition, the lime and silica particles are more or less insulated from each other, and conditions are set up which are not conducive to the formation of the proper chemical unions at this point. In other words, chemical unions between lime and silica, which are necessary to produce an agglomerate of proper consistency, are not reached at a point in the furnace where needed in order to keep the stock moving freely. It is believed that the descending stock encounters the hold-back action of the bosh coincidently with a large volume of thick viscous incipient slag, and the combination is sufficient to hold up the movement of the stock unless the blast pressure is reduced. If the above theory is correct, then it is a logical conclusion that it can be overcome by better preparation of the ore and possibly some small change in furnace lines, perhaps a slightly steeper bosh.

Another condition with which the southern operator has to contend is the high humidity during the summer time and the very wide variations in moisture content of the blast during the winter months. Strange as it may seem, the fact remains that during the winter months the humidity in this district varies much more widely than during the summer, and during our coldest months we will have variations in moisture content of from approximately 7 to 2 grains per cu. ft. within a very few days, and variations of 3 grains within one 24-hour period. During the summer months the moisture is very high practically all the time, and for periods will go as high as 10 grains or more. To an operator of a merchant furnace these moisture conditions are very trying, as coke consumption is seriously affected, but of still greater importance is the maintenance of iron on grade. To do this it is a continuous problem of trying to keep ahead of changes in the atmospheric conditions by raising or lowering the blast temperature, or by changes in the burden ratio, or both. On this account the conditioning of the air blast to maintain a constant moisture appears most attractive, and with the progress made in this art in recent years we feel that the time is at hand when air conditioning may be applied profitably to a blast furnace operation. The Woodward Iron Company has been studying this problem for some time and has now definitely proceeded with air conditioning on one furnace.

It is believed that a constant moisture content of the blast will yield certain benefits to the operation which are difficult to evaluate over and above any theoretical savings that may be realized in coke consumption. In actual practice a graphic picture of tonnage produced and coke consumed per ton of iron shows that up to three grains of moisture the results on the furnace are not markedly affected, but that both these figures are seriously affected at a very rapid rate as the moisture content rises from 3 to 10 grains.

The problem of flue dust in the past has been a serious one. Practically all of the furnaces have accumulated over past years mountains of flue dust, and up until very recently one furnace gave this material away to the railroads for fill. It has already been mentioned that there is now one plant which has installed sintering equipment and is sintering flue dust accumulation with the fine ore produced at the mine screening station. The flue dust production has been tied up with the amount of wind blown, and for the size of furnaces was very high as compared to northern practice. With better preparation of ores there has been a tendency to recede from the high volumes blown, with resulting lower flue dust production. The same furnace which formerly blew 57,000 to 60,000 cu. ft. of wind per minute is now blowing about 45,000 to 48,000 and flue dust production, which ran 200 to 300 pounds per ton, is now less than 40 pounds per ton with very much higher coke efficiency. The Woodward Iron Company had a very interesting experience some time ago when, on a basic and low silicon run of rather short duration. they ran for twelve consecutive days with a flue dust production of 11 pounds per ton.

An improvement that has come about in recent years is the substitution of slag pits at the furnaces for cinder ladles. This eliminates much switching and the maintenance of cinder bowls and trucks. The slag is dug from cooling pits either by the contracting slag company with its own power shovels or by the blast furnace operating department, loading it into cars for delivery to the slag company.

Some slag is also utilized in granulated form for use in manufacture of blast furnace cement. The method used is to discharge the slag from the cinder notch into a trough where it passes through a granulating spray and is then sluiced by swiftly moving water into railroad cars. One blast furnace plant operates a ready-mix

concrete plant, utilizing the slag from its furnaces and has a capacity of 1500 cu. yds. of concrete per day. The concrete from the plant is delivered in revolving mixers mounted on a truck chassis. The Republic Steel Corporation produces a light weight aggregate for concrete, insulation and masonry work. The molten slag from the furnace is poured into a rotating machine in which a very small amount of water is used and which contains paddles which whip the slag and break it up into small pieces.

Gas cleaning in the South has not progressed to any such extent as the northern furnaces. There is one dry electrical precipitator in the district, and one Feld washer, but all other plants have crude gas cleaning equipment, and there is not a single plant in the district that has sufficiently clean gas so that it can be used for under-firing coke ovens or can be used in very small checkered stoves. The Woodward Iron Company has two stoves equipped with 4 inch checkers which we believe are the smallest in use in this district. With the large checkered stoves it may be generally stated that the blast temperatures available are considerably below the more modern practice. In producing basic iron it is almost universal practice to use low blast temperature, probably never exceeding 1200 degrees F. and generally much lower.

The economics of very clean gas is a question subject to discussion, one argument being that it is more economical to build more stoves and maintain the larger checkers (6 to 9 inches) rather than install cleaning equipment capable of reducing the dust content down to .05 grains, or lower, and use the modern small checkered stoves, or the inserts in the checkers frequently used.

The pig iron from red ore alone will run from .80 to .82 phosphorous, and .30 to .32 manganese, so that it is generally necessary to add manganese ore to the burden to raise the content. The high phosphorous makes a very fluid iron of particular value in making thin castings. In physical appearance the southern iron has improved rapidly in recent years. It was not, however, until 1932 that the last of the sand cast iron disappeared. All furnace plants now have pig casting machines and all producers make a smooth clean pig of uniform structure. It is believed that better ore preparation, air conditioning and other improvements now in progress or about to be installed, will result in a still more uniform quality of iron.

As to the future progress of the southern furnace practice the following predictions may be made:

First: Finer crushing and better preparation of the red ore, with probable sintering of the fines, will probably be the first move. It is believed that when this is carried to its fullest extent we may reverse, or at least modify, our opinions as to the ease of reduction of this ore, and that instead of its being considered hard to reduce it may be looked upon as a fairly easily reduced ore.

Second: With the depletion of the better grades of ore will, of necessity, come some beneficiation of the lean ores, of which there are vast untouched quantities.*

Third: With the high moisture contents during the summer months and the widely varying humidity during the winter months, it seems most probable that air conditioning of the blast will be one of the developments for all southern furnaces in the near future, especially when consideration is given to the rapid advances made in this art in recent years. What may have been an economic impossibility a few years ago may now be an entirely feasible practice and economic possibility.

Fourth: All furnace coke will probably be crushed and sized, and all small sizes taken out and charged by itself, and in addition all breeze and very small sizes removed by screens at the furnace coke bins.

Fifth: With better ore and coke preparation will probably come a continued tendency to recede from the comparatively large volumes of wind blown without sacrificing coke efficiency.

Sixth: With better ore preparation, lower wind, and uniform moisture content, it is believed that the furnace will become free moving and that the common practice of periodic checking will disappear.

Seventh: Use of higher blast temperatures with its consequent reduction in coke consumption. This will probably not be accomplished except in very gradual steps.

Eighth: As a result of the demand for higher blast temperatures will probably come greatly improved gas cleaning, and with this will come the small checkered stoves having greatly increased efficiencies over the present equipment.

These things seem only natural logical developments, some of which are under way and some of which, tests have indicated, offer economic advantages that cannot be ignored. There may be many others but these seem the most probable immediate steps to further improve the quality of southern pig iron and to make the fullest use of the resources of this territory.

*"Known Iron Ore Reserves of the World and Their Significance", Charles Hart, IRON AND STEEL ENGINEER, MAY, 1939.

DISCUSSION

PRESENTED BY

G. M. HARRIS, Superintendent of Blast Furnace, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama.

E. A. HAWK, Fuel Engineer, Tennessee Coal, Iron and Railroad Company, Ensley, Alabama.

J. E. URQUHART, General Superintendent, Woodward Iron Company, Woodward, Alabama.

G. M. HARRIS: I think that unquestionably, Mr. Urquhart has dealt with the most pertinent facts and problems concerning southern blast furnace practice, and particularly the beneficiation of raw materials of this district.

Over the course of many years, southern operators have improved their furnaces mechanically by modifying their lines, the elimination of certain obsolescent

equipment and the adoption of more modern facilities, from which our practice has improved from a standpoint of efficiency. Yet, there remains much that can be done. The most fertile offering, I feel, lies in the proper preparation of our materials, and particularly in the fine crushing and sizing of ores, and ultimately the sintering of the fine sized quantity.

Considerable research has been conducted on the ores of this district as regards their degree of reducibility. Research and facts indicate that the degree of reducibility is unfavorable as compared to other ores of this country, being refractory in nature and rather dense, for which we can partially compensate by better preparation. The advantages of fine crushing arise from the fact that a greater surface area becomes exposed per unit of volume involved and affords better gas contact in shaft of furnace, and secondly, it minimizes the possibility of stack segregation.

The hematite ores of the Birmingham district are of sedimentary formation. In crushing ores of this nature, there is a tendency for the product to slab. It is not uncommon to see such ore pass through a crusher having a 2-inch setting, to be in slabs not in excess of two inches in thickness but in lumps of various widths and lengths up to ten and twelve inches. You can readily appreciate what occurs in the stack of a blast furnace when materials of this nature are charged. The coarse material either follows the center of the shaft or else goes to the walls of the shaft, and in the ultimate the furnace is only working part of the total cross-sectional area.

Mr. Urquhart rather forcibly brought out the desirability of effecting lump separation of the finely crushed ore. Our furnace practice has revealed the fact that unless this be done, considerable advantage of the finer crushing is lost, in that the finer ore particles have a tendency when charged into a furnace to fill the interstices of the stock column, thereby terminating in a rather dense structure or else affording a stimulus to channeling of stack gases.

My remarks so far have been directed towards beneficiating ores, yet I feel to accompany such a program consideration certainly should be given to the proper preparation of coke and other raw materials.

E. A. HAWK: In the test showing a reduction of 450 pounds of coke per ton of pig iron, and a 14 per cent increase in production, what was the approximate increase in blast pressure?

J. E. URQUHART: I think the blast pressure increased three or four pounds.

Discussion - PHENOLIC PLASTIC APPLICATIONS IN THE STEEL INDUSTRY

Continued from page 71

nated bearing has to be applied in the correct manner or it is not going to work.

In too many cases in the past—it is not so true today—we, as well as our competitors, have been called in and told, "Here is our bearing. You make us up a bearing like that". It does not work out nine times out of ten. The bearing has to be designed for a specific job. Where we are attempting to hold gauge it is necessary to minimize the thickness of the wall. Under proper conditions the neck will polish instead of get rough. If we start with the neck in good condition, we expect it to improve.

Fire cracks should be unknown as far as laminated bearings are concerned.

The alignment of the mill is of extreme importance on any laminated bearing. That importance may be realized if you will consider the fact that in operating a mill with misalignment on a roll, all that can happen to babbitt is that it will cold flow and the roll will adjust itself. The laminated bearing will not do this. Proper alignment is of vital importance for the successful use of laminated bearings.

J. E. HARRELL: I would like to ask Mr. Horne about the life with the pressure on the flat side as against the edges of the material.

H. F. HORNE: As you gentlemen doubtless know, some of the earliest bearings were of the "on-edge" construction. There is nothing wrong with that construction. It is ideal, as far as it goes, with the exception of the fact this material will only stand something like 2,000 pounds pressure per square inch, which is not enough for most steel mill practice, whereas in the flatwise direction the material has a compressive strength of around 22,000 pounds per square inch.

MEMBER: I would like to know one thing. Has phenolic plastic ever been applied to sound proofing of two metals?

H. F. HORNE: This material, as far as sound proofing characteristics are concerned, is not very good. The sound dampening properties of any material depend almost directly on its specific gravity, so that materials such as the various fibrous compounds on the market, which have a very low specific gravity, have a much better sound dampening effect than the plastic material. However, if you are thinking about insulating two moving metal parts so as to reduce sound, it will do that.

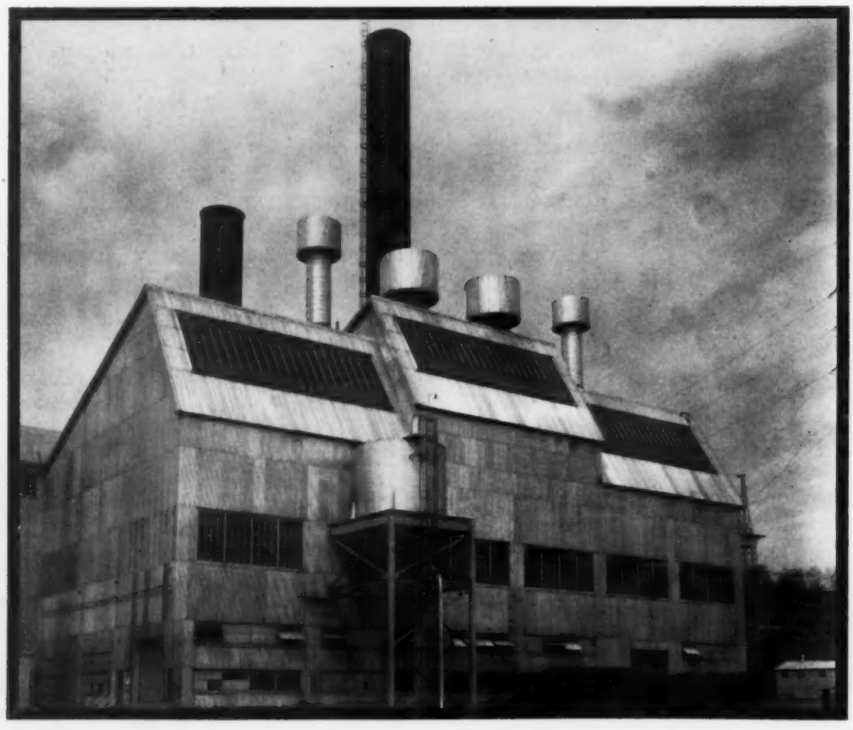
MODERN BOILER PLANT INSTALLATION AT IRVIN WORKS BUILT WITH EYE TO FUTURE

▲ By now everyone whose interests touch the steel industry has heard of the "Mill on the Hill", the modern Irvin Works of the Carnegie-Illinois Steel Corporation. Just as modern and efficient as the mill is the boiler plant which supplies its steam for process work and for building heating.

This steam boiler plant was furnished and installed by the machinery division of Dravo Corporation complete to specifications laid down by the engineers of Carnegie-Illinois Steel Corporation. The plans provide for future installation of two additional boilers which, when completed, will increase the steam output of this plant about 80 per cent. Much of the existing auxiliary apparatus has been designed for future or ultimate plant capacity.

There are two waste-heat boilers, of steel encased fire-tube type, rated at 670 hp. each, and having a total capacity of 25,000 lb. of steam per hour at 200 lb. per sq. in. pressure and 530 degrees F. temperature. Induced draft fans are installed, discharging to a stub steel stack. These boilers are not arranged for direct firing, but are heated by the waste gases from the slab heating furnaces in the hot strip mill. They supply

General view of Irvin boiler plant, showing overhead ash bin, and coal cars standing over track hopper.



Panels carry the gauges, instruments and automatic controls for each fuel-fired boiler.

about one-sixth of the total steam required in the plant.

There are also two fuel-fired boilers of three-drum water-tube type, 860 hp. each, operating on natural draft. They are equipped with chain grate stokers for burning coke or coal, and with gas burners for handling coke oven gas from Clairton Works if desired. Either fuel may be used alone or in conjunction with the other, giving a very flexible arrangement. Water walls are provided in the fuel-fired boilers, which are also equipped with automatic controls and a complete system of gauges and instruments. The steaming capacity of each boiler is 60,000 lb. per hour. Provision has been made for future installation of two additional boilers if required.

FUEL SUPPLY

Coal and coke are delivered to the boiler house in hopper cars and dumped into a track hopper from where a bucket elevator and belt conveyors move them to overhead bunkers. Chutes convey the fuel to the stokers. The fuel is weighed on its passage from bunker to stoker. The fuel handling system has a capacity of 40 tons of coal per hour.

Water for the entire mill is pumped from the Monongahela River to a reservoir located on the hill above the plant. From here the boiler water passes through a continuous hot process line and soda treating plant of 240,000 lb. per hour capacity. A secondary treatment of phosphate and tannin, and a deaerating feed water treatment insures a boiler feed free from scale-forming or corrosive properties. Feed water is handled by turbine driven centrifugal pumps.

A hydraulic ash-handling system removes ash from the pits under the fuel-fired boilers, and sluices it to a pit located in the basement. From the pit, the ash, mixed with water, is delivered to an outside overhead bin, from where it is put into railroad cars. The ash-handling system has a capacity of one-half to three-quarters of a ton per minute.

The most modern auxiliary equipment is used in this plant, and throughout the entire design and construction, emphasis was placed on flexibility, efficiency, and reliability.

NEW TYPE CIRCUIT BREAKERS SHOWN

▲ Those who were present at the demonstrations of the General Electric Company's two new oil-less type breakers came away from Schenectady well impressed with the fact that they had witnessed the beginning of an epoch in electrical history. The demonstration tests staged by the company's switchgear division for its approximately 250 utility, railroad, and industrial guests, showed conclusively that new air equipments had been developed capable of serving in applications limited to oil-type breakers heretofore.

Two new circuit breakers were demonstrated and tested. One, called the "Magne-blast" because it interrupts its arc magnetically, introduces an entirely new principle in the technique of fast circuit interruption in air. It is designed for use with standard vertical lift - type metal - clad switchgear, thereby realizing all the inherent advantages of this type of switch-gear. The magnetic blast breaker is intended for 5,000-volt service at interrupting ratings up to 150,000 kva.

The air-blast breaker is designed for 15,000-volt service at interrupting ratings up to 1,500,000 kva. As its name implies, the air-blast circuit breaker utilizes a blast of air built up under high pressure to interrupt the circuit and break the arc. In addition, the high-pressure air is used to operate the breaker. The stream of air removes the arc products causing the circuit to be interrupted at first current zero after the contacts have been parted.

The testing of the new oil-less breaker equipment took place in the high-voltage testing laboratory of the company's Schenectady works. As they should have been, the actual circuit interrupting tests in themselves were properly uneventful. One official of the company, at the conclusion of the tests, reminded the guests of the old saying that such tests are usually "viewed with disappointment if nothing happens; disgust if comething does." He congratulated the switchgear division in being able to "disappoint" its guests.

To demonstrate conclusively that the new type protective equipment could "take it," the interrupting ratings of both breakers were exceeded by as much as 50 per cent in the tests. In spite of this abnormal treatment, however, neither of the breakers showed any signs of damage when disassembled for inspection after being put through their paces.

Tests of the air-blast breaker were

H. E. Strang, G. E. switchgear engineer, tells about one of the stationary contacts of the new air blast breakers.

HEAT BAKES WIRING, TOO

If you returned from vacation with a sunburned, peeling, dehydrated hide, you have a faint idea of the insulation-wrecking baking that wiring takes in temperatures ranging from 150° to 250° F. and higher.

Heat may not work as fast on wire as old Sol did on your back, but if the insulation doesn't pack a plus quota of heat-resistance it will dry out and peel just as sure as your skin did. Under a high-temperature blasting from 8 to 24 hours a day the insulation of wire that is not positively heat-resisting (asbestos insulated) will gradually become as brittle as a cracker, then vibration will open up cracks permitting current leakage and the entrance of moisture. When that happens you can prepare to pull the wire out, replace it, and get ready to go through the cycle all over again . . . *unless you switch to* Rockbestos.

Play safe and save money by specifying Rockbestos asbestos-insulated wires for circuits that are subject to overloads or are located near steam lines, boilers, soaking pits, kilns, furnaces, other hot areas, or wherever a fire hazard exists. We'll be glad to send samples and our new No. 10-E Catalog. Rockbestos Products Corporation, 933 Nicoll Street, New Haven, Connecticut.

TEN TESTED ROCKBESTOS VALUES

1. Heatproof
2. Fireproof
3. Permanent
4. Lower maintenance cost
5. Resists heat and vibration
6. Saves work
7. Oil and Greaseproof
8. High overload capacity
9. Permanently flexible
10. Greater carrying capacity

At the Iron & Steel Exposition — Booth 49

ROCKBESTOS A.V.C.—*the wire with permanent insulation*

conducted first, with seven interruptions performed by the breaker. In the final test the breaker closed 80,000 amperes peak inrush current and interrupted 730,000 kva. after six cycles. Duration of the arc was only one-half cycle.

The tests on the magnetic blast breaker were equally severe. Again a succession of seven tests were staged that culminated in exceeding the breaker's interrupting rating by going up to 140,000 kva. at 4,200 volts on the last test. The magnetic blast breaker tested was a 5000-volt 100,000 kva. unit.

NEW STRIP MILL RECORDS

▲ Republic Steel Corporation's 98-inch continuous strip mill recently established what is stated to be new records for both hot and cold rolled steel. The record for hot rolling steel was a total of 1900 gross tons of finished coils, amounting to 35½ miles of steel with an average width of 55 inches was rolled between 7:00 A. M. and 3:00 P. M. The previous record for hot rolled steel in an eight hour turn was 1887 tons.

The record for cold rolled steel was 801.4 tons, amounting roughly to 39½ miles of steel, averaging between 50 and 63 inches in width, was rolled from 11:00 P. M. to 7:00 A. M. The previous record for cold rolled steel in an eight hour turn was 707 tons.

LINED PIPE FOR CORROSIVE FLUID

▲ Jones and Laughlin Steel Corporation, Pittsburgh, has perfected an improved process for the manufacture of cement-lined steel pipe for the transmission of highly corrosive fluids. The product is made on a new high speed mill especially designed for the purpose by the Jones and Laughlin engineering department. One of the features of the new plant is a pilot ball mill in which trial batches of the pipe lining mix are ground in order to determine the correct formula for each specific application before production batches are ground in the main ball mill.

In the process, a special formula, not available on the open market, is used in lining the pipe. A measured quantity of the special mix is placed in the pipe and forced against the walls by a process which, at the same time, extracts a high percentage of the water. This, cement experts agree, is desirable in attaining a lining with the highest physical properties. The process results in extremely even distribution of the mixture. After curing, the pipe is given a final inspection and made ready for shipment.

The combination of the special mixture and the process produces an even interior coating in the pipe, so smooth that the lining has a lower friction coefficient than the original pipe, yet is strong enough that no special handling in the field is required to protect the lining, except that the pipe cannot be deformed. The pipe can be shipped, cut to length, and fitted just as unlined pipe, the lining being able to withstand without chipping any blow on the exterior of the pipe which does not actually dent the pipe. This pipe has the same working pressure as regular steel pipe and, while Jones and Laughlin does not manufacture fittings, it is in a position to supply lined fittings for use with this pipe, which is available in sizes of ½ to 12 in., inclusive, and 14 in., outside diameter, in special cases.

INSTRUMENTS OF IMPROVED DESIGN

▲ An entirely new and improved line of temperature and pressure recorders, indicators and controllers has just been placed on the market by the Brown Instrument Company. These instruments include thermometers indicating and recording types for temperatures from -40 degrees F. up to 1200 degrees F.; and indicating or recording pressure and vacuum gauges for ranges from 6 lb. of water up to 2500 lb. per sq. in. and on vacuum ranges of 10 in. of mercury and over. All types are offered in one, two or three pen models.

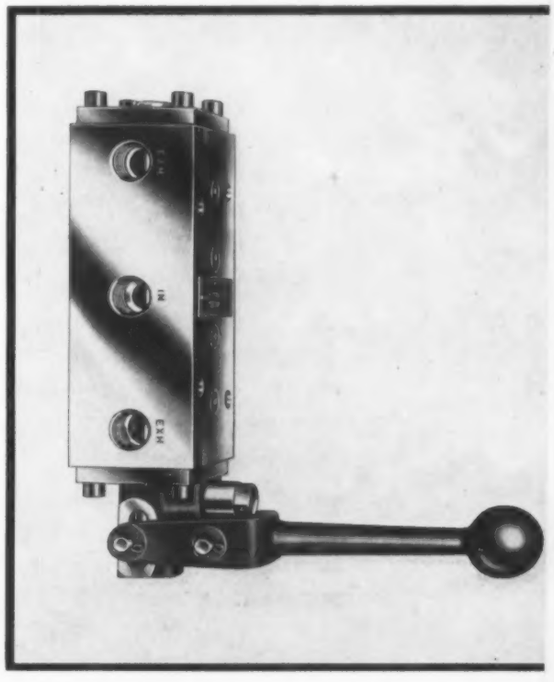
Advanced design of the operating mechanisms, in this new line of rectangylar case instruments, is the result of years of research and field testing under actual operating conditions. The powerful, flat, spiral actuating elements have ample pen torque without sacrificing speed of response. Especially heat-treated to insure permanent calibration, they have exceptional over-range capacity.

SINGLE PLUNGER AIR OR HYDRAULIC VALVE

▲ A new air or hydraulic valve, with a single plunger construction affords many advantages to machine designers and engineers. This sturdily constructed valve is the last word in simplicity, having only one moving part. With outlets and inlets in the sides, it can be serviced on the job without dismounting. Having individual exhaust outlets controlling each end of a double-acting cylinder, speed control of the piston is easily obtained independently in either direction.

The most commonly used sizes have extruded brass housings. There is no lubrication problem as there is no metal-to-metal contact, in fact the higher the pressure the tighter the seal. The sizes of this valve, developed and manufactured by the C. B. Hunt and Son Company, ranges from ⅛ inch to 1½ inches.

A new air or hydraulic valve, with a single plunger construction.



YOU *Can't* AFFORD *to Miss* IT!

Prominent Steel Engineers who attended last year's Convention.

Steel plant engineers and operators are prolific in their expressions of the interest and value of the Annual Convention and Iron and Steel Exposition of the Association of Iron and Steel Engineers. Many have stated that it is not possible to attend this gathering of steel plant men without accumulating numerous practical ideas that are applicable to their particular plants.

A complete coverage of steel mill practice will be found at the technical sessions—all of the latest designs and developments will be on exhibit in the Iron and Steel Exposition—two inspection trips to the Pittsburgh districts most modern steel plants—and at this convention you will find the leading authorities on modern steel mill operation.

Make your plans now to attend the

35th Annual Convention

and

IRON AND STEEL EXPOSITION

of the

Association of Iron & Steel Engineers

WM. PENN HOTEL, PITTSBURGH

Sept. 26 - 27 - 28 - 29, 1939

ITEMS OF INTEREST

John G. Munson has been elected vice-president, raw materials, United States Steel Corpotion of Delaware, succeeding Thomas Moses, who recently retired. Mr. Munson has been president of the Michigan Limestone and Chemical Company since 1928.

Mr. Munson was born in 1885 at Bellefonte, Pennsylvania, and subsequently received his bachelor of science degree at Yale in 1905. During the next year he served as a rodman in connection with tunnel construction in Washington, D. C. From 1906 to 1908 he served as superintendent of water supply construction in New Haven, Connecticut, and sewage disposal construction at Baltimore, Maryland. In 1909 he became superintendent of J. G. White Engineering Corporation, a position which he held until 1919, when he joined United States Steel Corporation subsidiaries as operating manager of Michigan Limestone and Chemical Company. He was elected vice-president of that company in 1925, and in 1928 became president and a director.

R. B. Nichols has just been elected secretary of the Bantam Bearings Corporation, South Bend, Indiana, subsidiary of the Torrington Company, Torrington, Connecticut. Mr. Nichols has been associated with the bearing business for the past fifteen years, most of this time at Bantam.

His wide experience with bearings and bearing problems comes from long contact with actual factory production, having risen from the ranks to the office of superintendent at Bantam, later being made sales manager. In addition to his new duties, Mr. Nichols will continue as sales manager of Bantam, the position he has held for the past three years.

Ambrose N. Diehl has retired from the presidency of Columbia Steel Company, after an active career of forty years' service to the steel industry. Beginning in 1899 Mr. Diehl entered the employ of Carnegie Steel Company as a chemist in the laboratory of the Duquesne Works. Rising through the various operations, he became assistant general superintendent of the Duquesne Works in 1915, and operating vice-president in charge of the Pittsburgh district of Carnegie Steel Company in 1918.

In 1930 he was made vice-president of the United States Steel Corporation, and in 1932 was sent to San Francisco to head the new Columbia Steel Company as president.

William A. Ross was elected president of the Columbia Steel Company, subsidiary of the United States Steel Corporation. Mr. Ross succeeds Ambrose N. Diehl, who resigned because of ill health.

The new president of Columbia Steel has been connected with steel industry since 1895, when he went to work for the Washburn Moen Manufacturing Company as an office boy. In 1899, this company was acquired by the American Steel and Wire Company, and he served this new firm as bill clerk and cashier. In 1911 he was appointed assistant treasurer and then assistant to the vice-president of the United States Steel Products Company. In 1930, after the consolidation of the United States Steel Products Company into the Columbia Steel Company, he was made vice-president and treasurer. By 1932, he was appointed vice-president and general manager of sales, in which capacity he served until his recent election to the presidency.

H. W. Graham has been appointed director of metallurgy and research, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Mr. Graham, who has been general metallurgist for many years, has been connected with that company since June 1914, following his graduation from Lehigh University.

C. C. Henning was made general metallurgist for the Jones and Laughlin Steel Corporation. Mr. Henning has been identified with Jones and Laughlin since 1915, in the Pittsburgh Works metallurgical department. In 1935, the American Institute of Mining and

R. B. NICHOLS

JOHN G. MUNSON

A. N. DIEHL

Metallurgical Engineers conferred upon him the Robert W. Hunt Award for his paper, "Manufacture and Properties of Bessemer Steel".

Neil Currie, Jr.
was made assistant to the vice-president in charge of manufacturing, General Electric Company, Schenectady, New York. Mr. Currie started his service with the company in 1908, in the employ of the power apparatus department of the Western Electric Company following his graduation from the University of Minnesota as an electrical engineer. With the purchase of that department by the General Electric Company, Mr. Currie joined the motor department of General Electric, then located at the Pittsfield Works. In 1911, he was named assistant engineer of the power motor engineering department; in 1920, engineer; and five years later, managing engineer. In 1929, he was named manager of the Philadelphia Works, and on February 1, 1936, he was appointed manager of the Fort Wayne Works.

Lawrence E. Joseph
was appointed executive officer in charge of the Blaw-Knox Division of the Blaw-Knox Company, Pittsburgh, Pennsylvania. Mr. Joseph succeeds R. F. McClosky, Sr., a company vice-president, who was placed in charge of the development of new products for the entire corporation.

F. A. Wright
has been appointed manager of resale sales for Cutler-Hammer, Inc., Milwaukee, Wisconsin. Mr. Wright, who succeeds B. M. Horter, now general sales manager, is a graduate of the University of Michigan's school of electrical engineering.

J. Douglas Darby
has been appointed manager of sales, Philadelphia district, Carnegie-Illinois Steel Corporation, with headquarters in Philadelphia. Mr. Darby, a native Phildelphian, has been associated with the steel industry in operating and sales capacities for 19 years. Following his graduation from Yale in 1919, he was employed in the open hearth department of Alan Wood Steel Company. He subsequently became general superintendent, steel division, and assistant to the vice-president in charge of sales.

Thomas Moses
vice-president, raw materials, United States Steel Corporation of Delaware, recently retired. Mr. Moses was born at Audenreid, Pennsylvania, August 18, 1869. He attended public grade school for two short terms and received private instruction at home. Mr. Moses later advanced his education by completion of a correspondence course. He was employed in the coal mines of Indiana at the age of 11, and at 14 became a coal miner. In 1888 he went to the Illinois coal fields where he filled various positions until 1905.

Mr. Moses served as secretary of the Illinois State Mining Board from 1905 until 1907, and from 1907 until November 1910, was Illinois state mine inspector. From 1910 to 1915, he was superintendent of operations of the United States Fuel Comapny, succeeding in 1915 to the position of general superintendent.

Mr. Moses became president of the H. C. Frick Coke Company, and other coal producing subsidiaries of United States Steel Corporation, in 1927. On January 1, 1938, he assumed the title and responsibilities of the office of vice-president, raw materials, United States Steel Corporation of Delaware, holding this position until August. Mr. Moses will continue in a consulting capacity.

B. F. Mercer
joined the steel foundry sales staff of the Allegheny-Ludlum Steel Corporation, with headquarters at Brackenridge, Pennsylvania. Mr. Mercer has been associated with the steel foundry trade since 1912, when he served the Union Steel Casting Company, Pittsburgh, as foreman and then as general superintendent until 1928. In 1929 he entered the employ of the Pittsburgh Steel Foundry Corporation as manager of the Sharon Works. From 1930 until 1933 he acted as vice-president in charge of operations for the Union Steel Casting Company. During the latter part of 1933 he became associated with the National Erie Corporation, in Erie, retaining the post of sales representative until his present appointment.

Charles E. Webster
has been appointed general manager of the Timken Roller Bearing Company, Ltd., Toronto, Ontario, Canada, with headquarters at 55 Charles Street, West.

Obituary

C. R. Ellicott
who has been general manager of the Bethlehem Steel Company's Cambria plant, Johnstown, Pennsylvania, died in his fifty-fourth year. Following graduation from Lafayette College in 1908, Mr. Ellicott joined Bethlehem as a chemist at the Bethlehem plant. In 1913, he was named superintendent of No. 1 open hearth, and in 1915 he was named superintendent of No.1 and No. 3 open hearths.

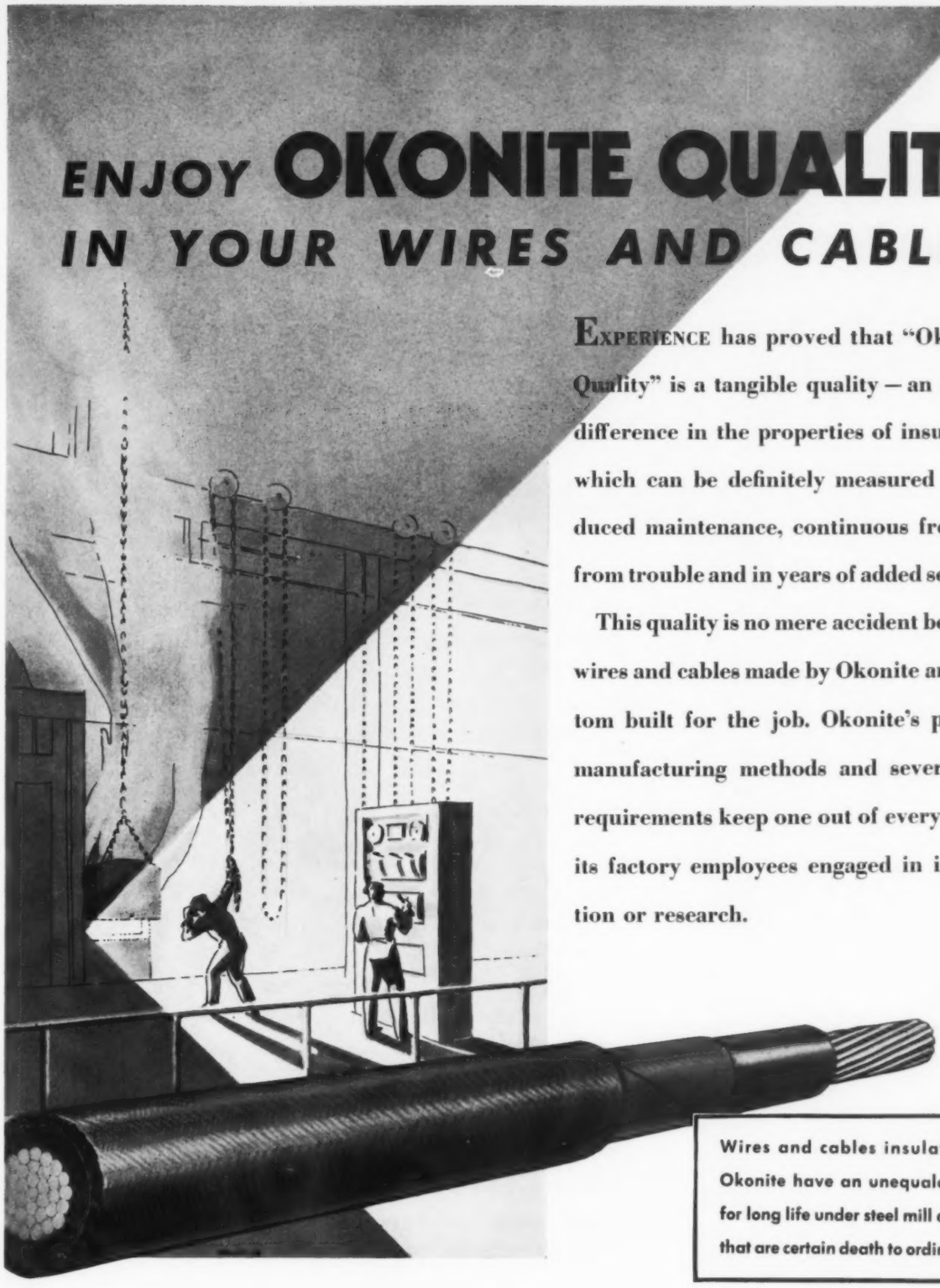
C. R. ELLICOTT

From 1917 to 1922 he was superintendent of the hot metal division, comprising blast furnaces, open hearths No. 1 and No. 2, tool steel and merchant bar mills. In 1922 he was appointed superintendent of furnaces and alloy mills of the Lehigh division of the Bethlehem Steel Company.

In 1936, Mr. Ellicott was made general manager of the Cambria Works, and held this position until his recent death.

John R. Booher
advertising manager of the Cleveland Crane and Engineering Company, Wickliffe, Ohio, died recently. Mr. Booher, prior to his affiliation with the Cleveland Crane and Engineering Company, was connected with Luetkemeyer Company, Pittsburgh; Doubleday-Hill Electric Company, Pittsburgh; Western Electric Company, Pittsburgh and Cleveland; and the Cuyahoga Power and Construction Company, Cleveland.

ENJOY OKONITE QUALITY
IN YOUR WIRES AND CABLES



EXPERIENCE has proved that "Okonite Quality" is a tangible quality — an actual difference in the properties of insulation which can be definitely measured in reduced maintenance, continuous freedom from trouble and in years of added service.

This quality is no mere accident because wires and cables made by Okonite are custom built for the job. Okonite's precise manufacturing methods and severe test requirements keep one out of every six of its factory employees engaged in inspection or research.

Wires and cables insulated with Okonite have an unequaled record for long life under steel mill conditions that are certain death to ordinary wire.

OKONITE **THE OKONITE COMPANY**

Founded 1878

EXECUTIVE OFFICE: PASSAIC, NEW JERSEY

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New York Boston Seattle Buffalo Chicago Dallas Detroit Atlanta
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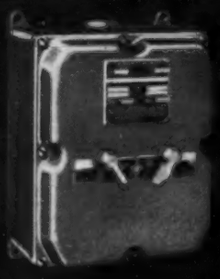
OKONITE QUALITY CANNOT BE WRITTEN INTO A SPECIFICATION

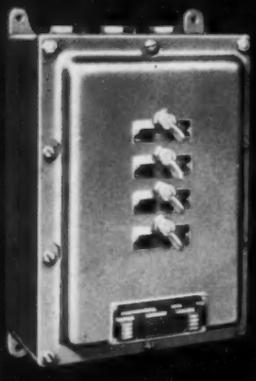
CROUSE-HINDS
Type DVS
CIRCUIT BREAKER CONDULETS

Dust-Tight, Vaportight, and Weatherproof



Type DVS Size A
For Two Single-Pole
Circuit Breakers

Type DVS Size B
For Three Double-Pole
Circuit Breakers



Type DVS Size B
For Four Single-Pole
Circuit Breakers

Type DVS—Size B
For Six Single-Pole
Circuit Breakers

Wherever weatherproof or dust-tight enclosures are required or the conditions necessitate sturdy, protective housings, the type DVS circuit breaker Condulets are ideal. They are built to Underwriters' Laboratories' Inc., standards for Class II hazardous locations.

Thermal circuit breakers made by several manufacturers may be installed.

The type DVS Condulets illustrated at the left are arranged to take two, four, or six single-pole and two or three double-pole, 15 to 50-ampere circuit breakers. These Condulets are furnished with a terminal block on which is mounted a neutral bus-bar with wire terminals, so that the circuit breakers may be used independently or connected and used as a panelboard.

Other type DVS Condulets are available for single circuit breakers, one, two or three-pole, 15 to 600-ampere.

Condulet Catalog No. 2500 will be sent on request.

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CROUSE-HINDS COMPANY
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Sales Offices: Atlanta — Birmingham — Boston — Chicago — Cincinnati — Cleveland
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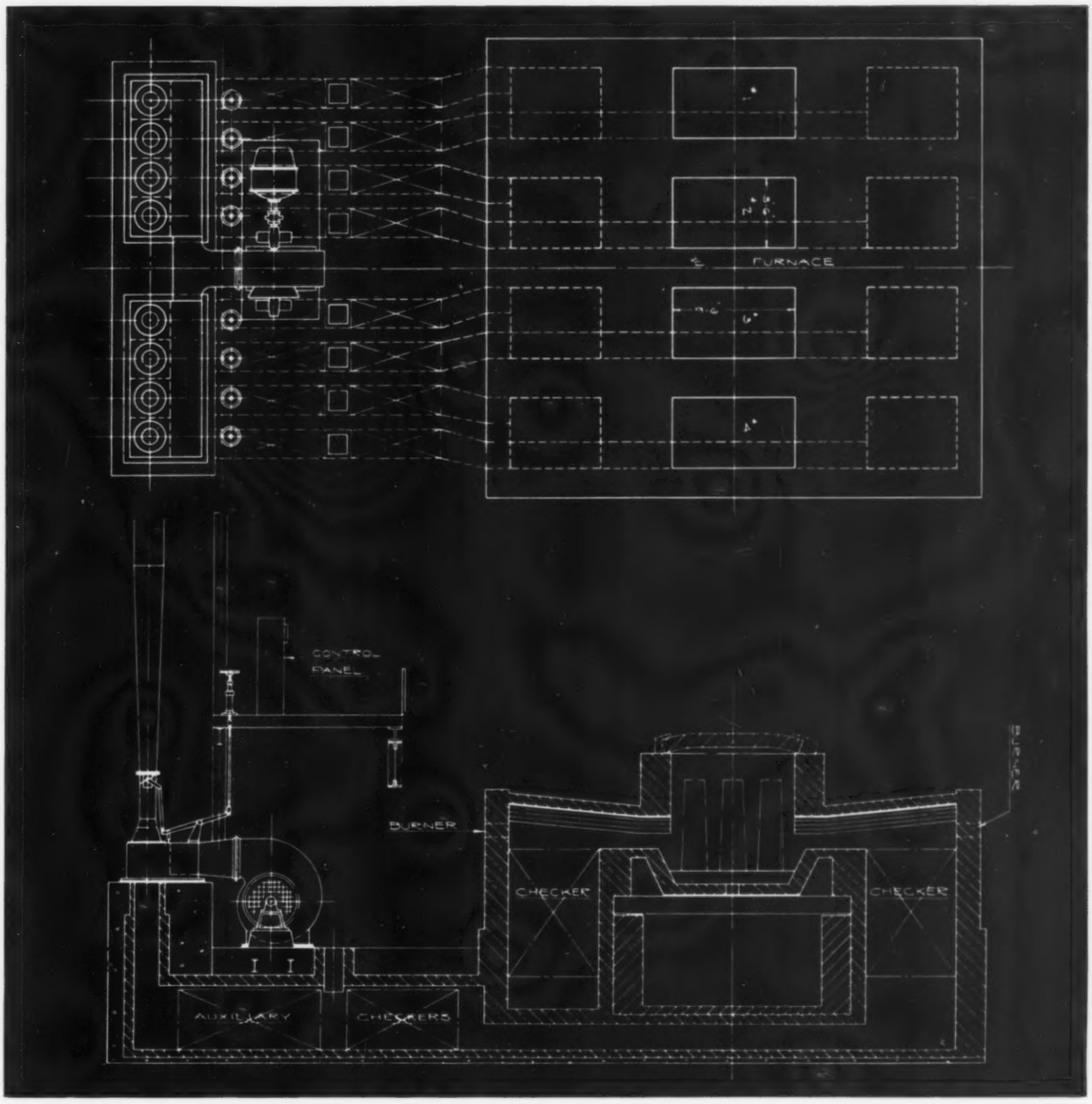

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Give your heater a chance to do a real heating job with dependable equipment — and he will save time, fuel and money for you.

The Isley Furnace System will make each hole of your soaking pits an independent unit. There are no draft or air dampers to leak, freeze or burn off. It will afford accurate control of furnace pressures and of combustion air supply. If blast furnace or low-b.t.u. mixed gas is used, it will increase temperature in the air, maintain a real flame for the job.

Automatic reversal with the Isley Furnace System relieves the heater of routine operations—gives him time to do a better job—and gives you a better product at lower cost. Send for the new Isley Bulletin.

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ISLEY Furnace Control System

NOW YOU CAN HAVE AUTOMATIC PROTECTION

for as little as

$2.00 LIST PRICE

with these *New* TYPE "MO" COLT MULTI-BREAKERS

entirely automatic . . . safe . . . no parts to replace

These new type "MO" Colt Multi-Breakers are available in 15, 20 and 25 ampere capacities . . . 115 or 115/230 volts A. C. They feature the famous Multi-Breaker mechanism . . . operate automatically . . . require the replacement of no parts after tripping. Easy to install . . mechanism permanently attached to cover. They embody the very latest features of small circuit breaker design . . and they will save time, worry and expense in your plant.

Send for Circular Describing "MO" Breakers in Detail

See the Colt Exhibit in Booth 26 at the Iron and Steel Show

COLT **ELECTRICAL PRODUCTS**

MANUFACTURED BY A WORLD FAMOUS ORGANIZATION

COLT'S PATENT FIRE ARMS MFG. CO., HARTFORD, CONN.

ELECTRICAL DIVISION

Neloy flame hardened industrial Gears and Track wheels

Note the discoloration on the flame-hardened surfaces of the gears shown above . . . An unretouched photograph.

You have at your command, when you do business with National-Erie, a wide range of gear cutting equipment for the production of spur, bevel, mitre, Sykes continuous Herringbone gears . . . The complete facilities of modern machine shops manned by expert machinists . . . Moreover, you have heat-treating facilities for fully quenched gears, which together with electric and open-hearth furnace foundry facilities, permit complete control of the manufacture of the materials you order . . . As you note above, a typical group of diversified industrial Neloy gears and crane track wheels for Neloy Flame Hardening treatments No. 10A and No. 10B . . . Make your source of supply for special steel castings and finished parts for your equipment, the National-Erie Corporation . . . Bulletins No. 5 and No. 6 are worth having on file for constant reference . . . They are yours for the asking.

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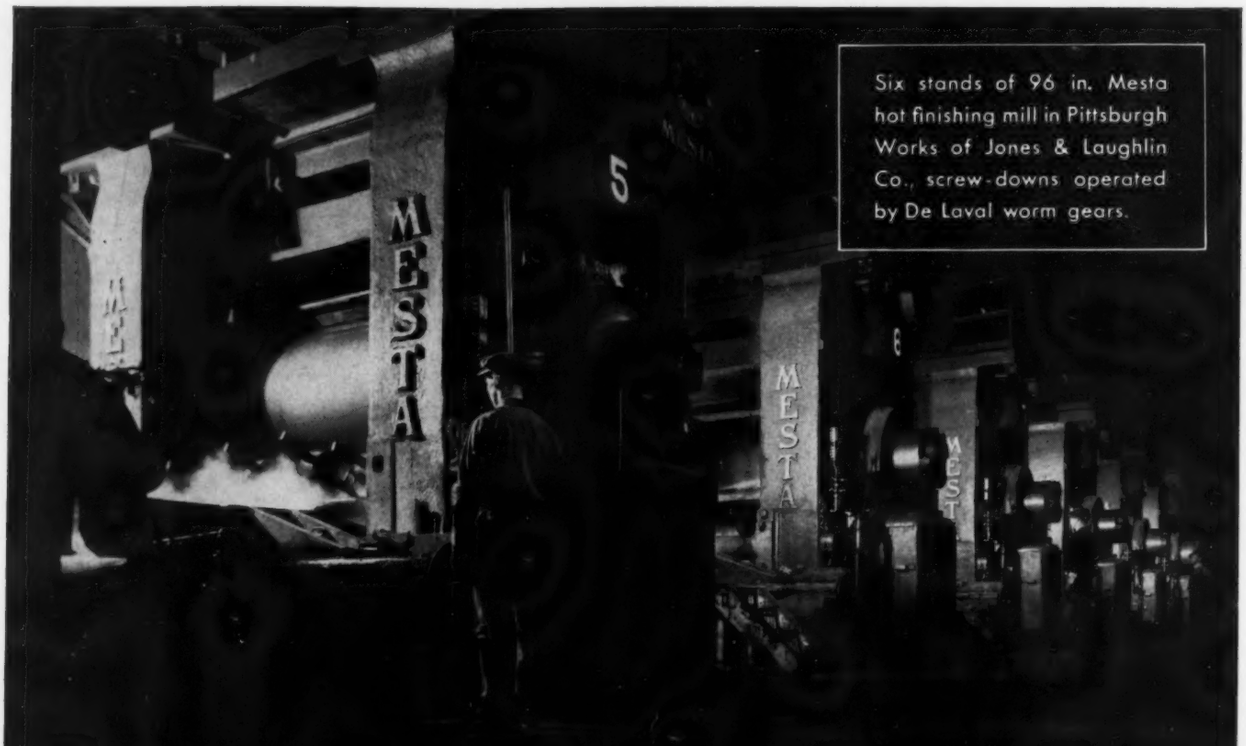
ERIE, PA., U.S.A.



Six stands of 96 in. Mesta hot finishing mill in Pittsburgh Works of Jones & Laughlin Co., screw-downs operated by De Laval worm gears.

For smooth application of great force

use **DE LAVAL WORM GEARS**

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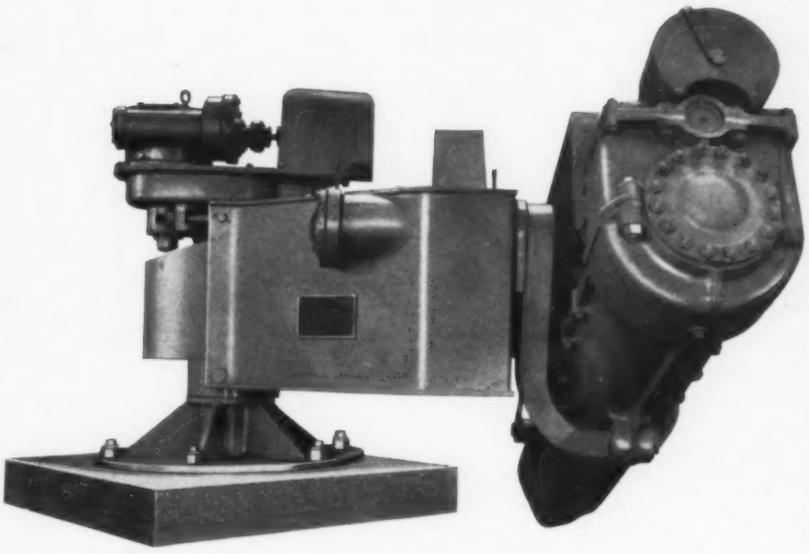
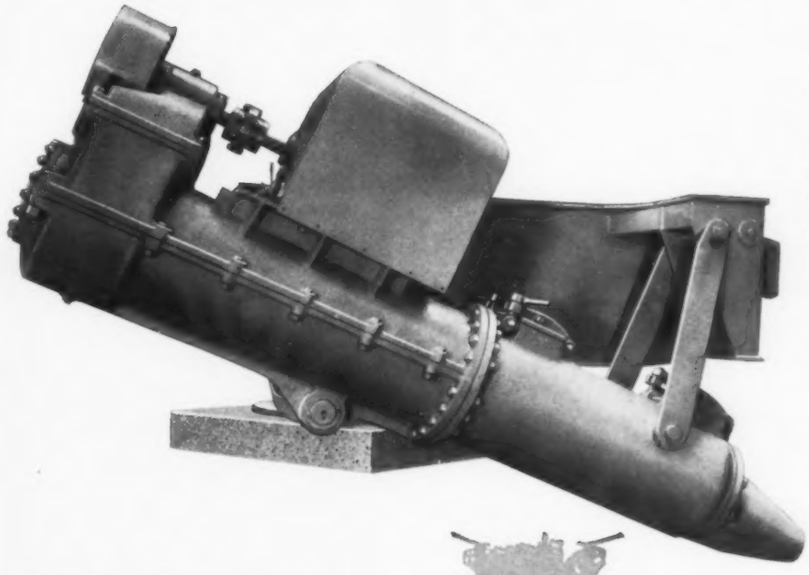
DE LAVAL STEAM TURBINE CO. . . TRENTON, N. J.

THE BAILEY ELECTRIC PLUNGER CLAY GUN



THE BAILEY COMPANY marketed the original electrically operated Blast Furnace Clay Gun, with Independent Pedestal, in 1928 and are now offering an improved design of electric plunger type gun. The independent pedestal guarantees the movement of the gun in exactly the same path so that the nose of the gun always enters tapping hole. The plunger or piston is operated by an internal screw motor driven. A long hole or long plug is absolutely certain, due to the quantity of clay and to the high pressure at the nozzle, which produces a denser, harder plug and makes for sureness and safety in stopping the tapping hole. Time required: 30 to 45 seconds.



This Gun will stop the tapping hole with full wind on the furnace at every cast. Continuous movement of the stock, due to the constant wind pressure, produces a smooth operating furnace with a steady flow of gas to the stoves, fewer tuyere changes, less flue dust and increased tonnage.

Weight—Approximately 22,000 lbs.

Clay Capacity—9.6 cu. ft.

BUILT UNDER U. S. PATENT 1,780,485

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Open Joint Stove Checkers
Thermal Goggle Valves
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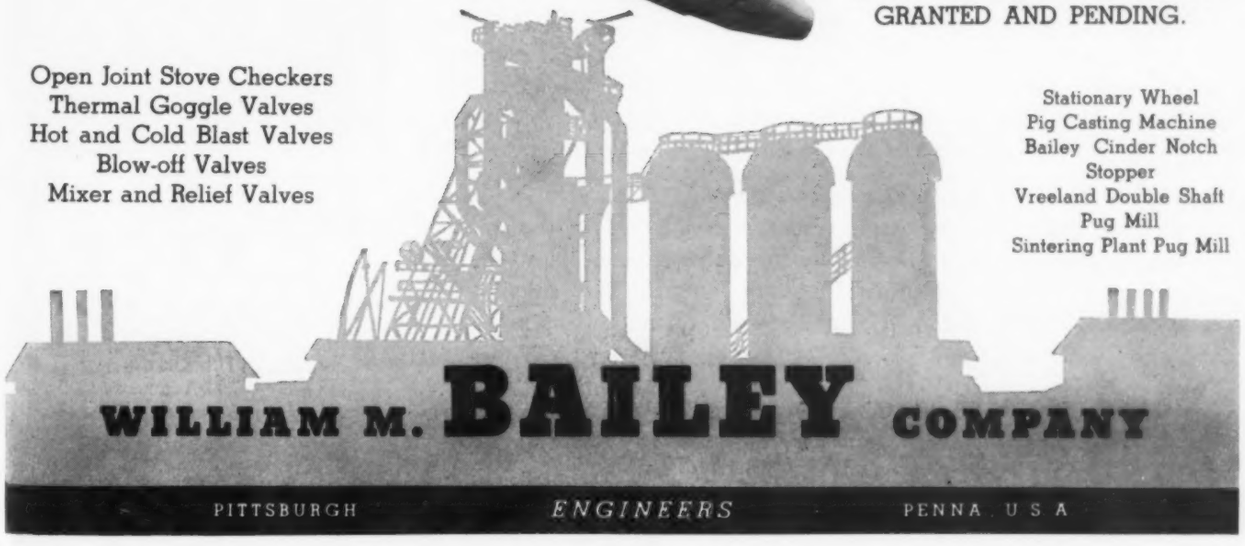

Stationary Wheel
Pig Casting Machine
Bailey Cinder Notch Stopper
Vreeland Double Shaft Pug Mill
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WILLIAM M. BAILEY COMPANY

PITTSBURGH *ENGINEERS* PENNA. U S A

the new Exide Charge Control Unit makes battery charging practically .... *AUTOMATIC!*

To save literally hours of maintenance men's time, install an Exide Charge Control Unit on your charging panel. Then the process of re-charging Exide-Ironclad Batteries becomes a matter of turning a knob. Once set, the unit sees that the battery gets a full charge at the proper rate without further attention. What's more, it cuts the circuit and signals when the charge is complete.

This unit is so reasonable in cost that in the course of a year it will normally pay for itself several times over, on time saved alone. In addition, it insures better truck performance, and longer battery life. There is an Exide Charge Control Unit suitable for Exide-Ironclad Batteries of every size up to 66 cells. Why not write for full details today?

Exide
IRONCLAD
BATTERIES
With Exide **MIPOR** Separators
"MIPOR," Reg. U. S. Pat. Off.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

Bring Lighting Maintenance DOWN TO EARTH

and save these 4 ways:

Hanges applied to high-bay reflector. Shown in closed position.

1. More light from cleaner bulbs and fixtures

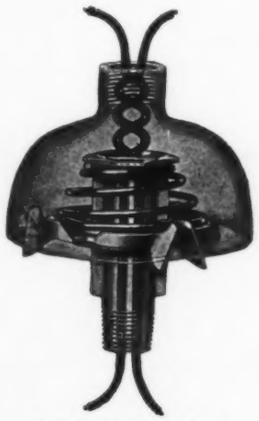
2. Longer life from lighting equipment

3. Lower labor cost

4. Freedom from accident

For 27 years and in hundreds of places, indoors and out, Thompson Lamp Lowering Hangers have been making lighting maintenance a convenient, economical, and safe operation . . . and, on the average, saving their cost in less than 2 years.

Whenever there is a lighting fixture, inside or out, mounted more than 12 feet high, it's very probable a Thompson Hanger would save money, safeguard your employees, and improve working conditions.

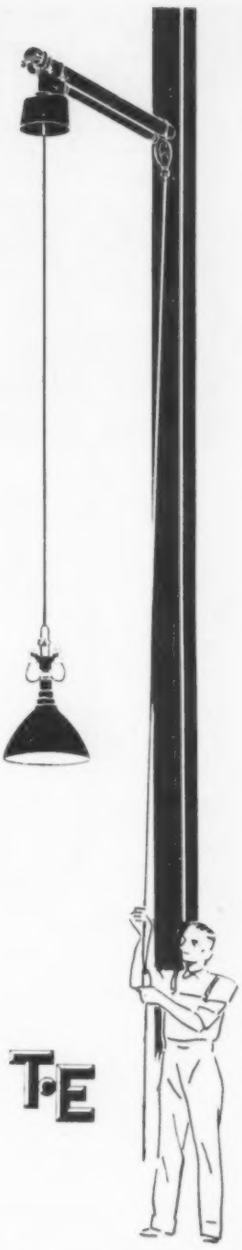


X-Ray view of shock absorber showing method of wiring.

INCREASE LAMP LIFE

Shock and vibration play havoc with light bulbs, shortening their life sometimes to only a few hours. But with Thompson Shock Absorbers, these destructive forces are curbed and lamp life is prolonged—often as much as 10 times.

Rugged in construction, with no bolts, nuts, or screws to work loose, and with a selection of springs to accommodate fixtures ranging from 1½ lb to 65 lb, they afford bulbs and fixtures the maximum protection. They are usable either with or without the lamp lowering hanger and can be employed to protect many other suspended devices.



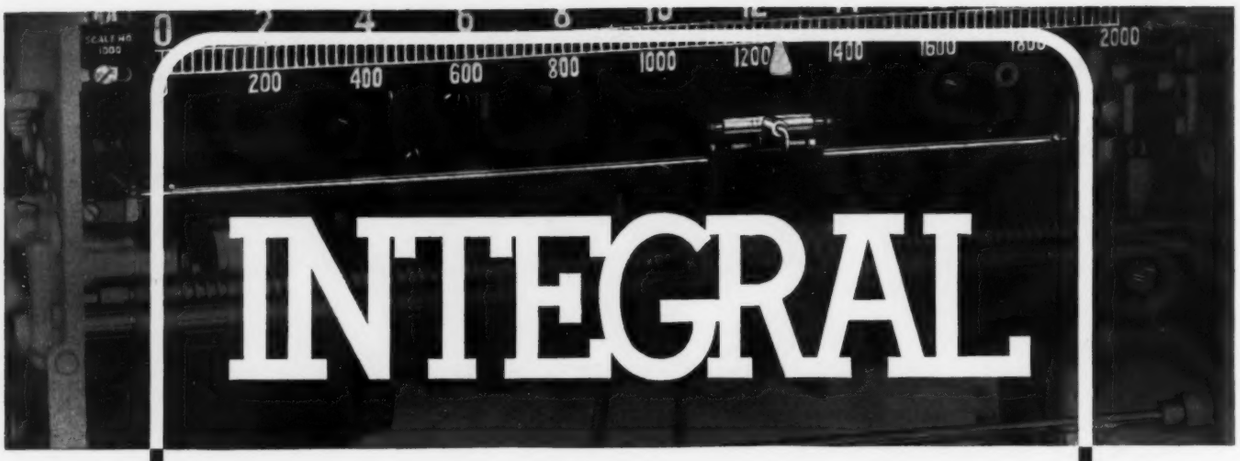
Thompson equipment is sold through leading electrical wholesalers

SOLVE SUSPENSION PROBLEMS

Thompson Electric has a wide variety of suspension fittings, both of the gravity and sway-limit type. They have many applications beyond their use with lamp lowering hangers, for example, the mounting of fans, blowers, unit-heaters, lighting fixtures, etc. **Catalogue #39** gives much useful information about these fittings and their numerous applications. Ask your electrical supplier for a copy, or write Thompson Electric Co.

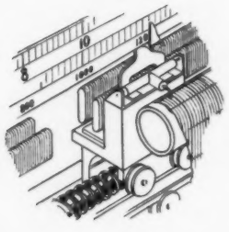
THOMPSON ELECTRIC COMPANY

1101 POWER AVE. **CLEVELAND, OHIO**



INTEGRAL

pen and slide wire contact



Another feature of **BRISTOL'S WIDE-STRIP PYROMETER**
contributing to fine performance

Mounted on one and the same carriage, the slide wire contact and the recording pen in Bristol's Wide-Strip Potentiometer Pyrometer form an integral unit. This not only simplifies construction but it does even more. It completely eliminates errors due to backlash,—errors that you always have with linkages and other connections of dubious worth.

The lead screw that drives the slide wire carriage is itself positively driven by an induction motor. There are no friction clutches and no ratchet mechanisms to bother with.

The recording pen is securely mounted between spring-tight cone pivots. Yet it can easily be removed; and, after inspection or cleaning, quickly replaced without in any way affecting the instrument calibration.

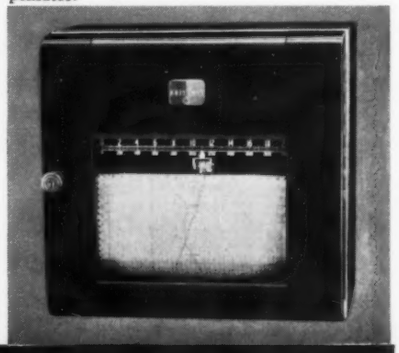
And so it goes. One feature after another. All combining in this Bristol's to offer you the finest wide strip potentiometer that money can buy. It welcomes and challenges comparison! Write for Catalog 1452H.

THE BRISTOL COMPANY
WATERBURY, CONNECTICUT

Branch Offices: New York, Boston, Philadelphia, Pittsburgh, Birmingham, Akron, Detroit, Chicago, St. Louis, Los Angeles, San Francisco, Seattle. Canada: The Bristol Company of Canada, Limited, Toronto, Ontario. England: Bristol's Instrument Company, Limited, London, N.W.10

CRAFTSMANSHIP
you can see at a glance!

Reflecting throughout the simplicity, beauty and perfection that identify the genius of the master craftsman, this Bristol's Wide-Strip Pyrometer possesses many other interesting features that you will want to know about. The following will be discussed in subsequent advertisements: (a) Circuit automatically standardized, (b) Electric balancing, (c) No lost motion, (d) Visible operating mechanism, (e) Extra wide 12¼ inch chart, (f) Duplex slide wire accuracy, (g) Large easy to read scale, (h) Automatic cold junction compensator.



BRISTOL'S
TRADE MARK REG. U. S. PAT. OFF.
Wide-strip Pyrometer

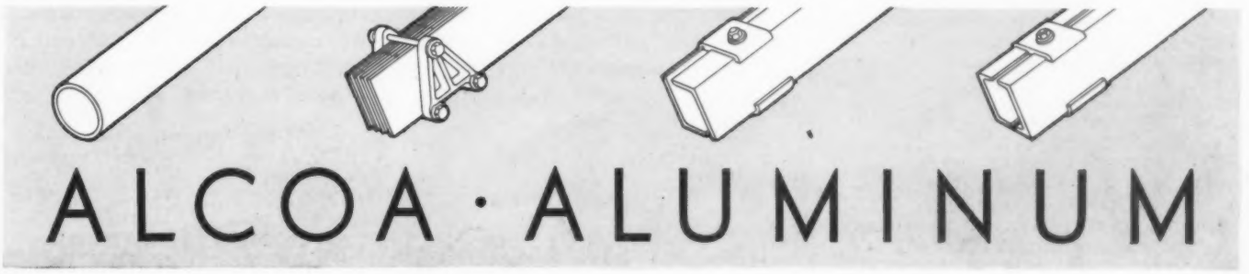
RECORDING ★ CONTROLLING ★ MULTIPLE RECORD MODELS

THESE WEST PENN® POWER COMPANY SUBSTATIONS ALL EMPLOY

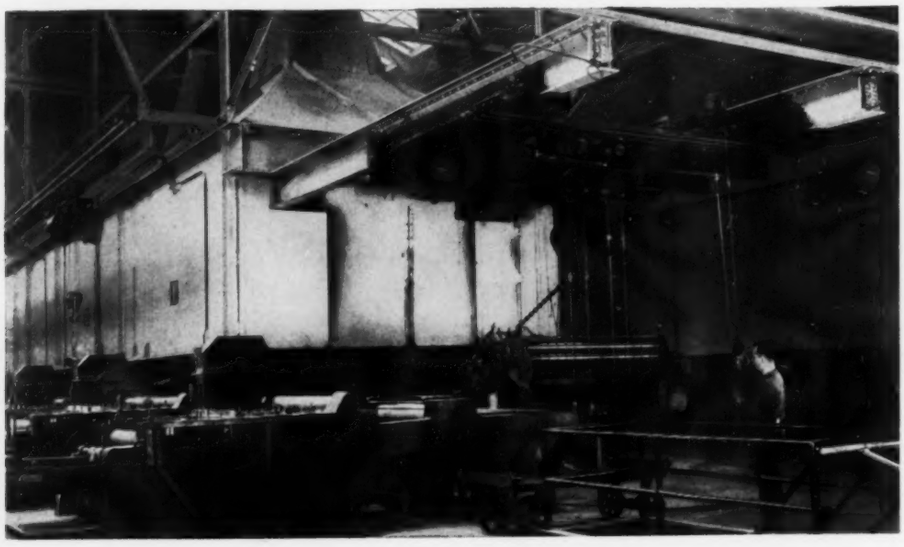
Tubular Alcoa Aluminum Bus Bars

Tubular Aluminum Bus Bar, though light in weight, has the rigidity required where supports are widely spaced. Deflections are small, construction is neat in appearance, and stays that way.

Standard construction methods are used with Alcoa Aluminum Bus Bar—tubular, flats, channels or angles. Inexpensive fittings are available. Our engineers will gladly assist you in selecting materials best suited to your needs. ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh, Pennsylvania.



ALCOA · ALUMINUM



Above is a special 3-motor Euclid crane; also, a Euclid monorail hoist, at the new Irvin Plant of Carnegie-Illinois Steel Corporation.

There are seven Euclid installations at Irvin; nine at Edgar Thomson; and dozens of others at the various Carnegie-Illinois plants. Carnegie-Illinois has been purchasing Euclid equipment for many years.

If your handling job is difficult, let us discuss it with you.

Pittsburgh Representative:
L. S. ADAMS
5545 Darlington Road.

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Euclid, Ohio

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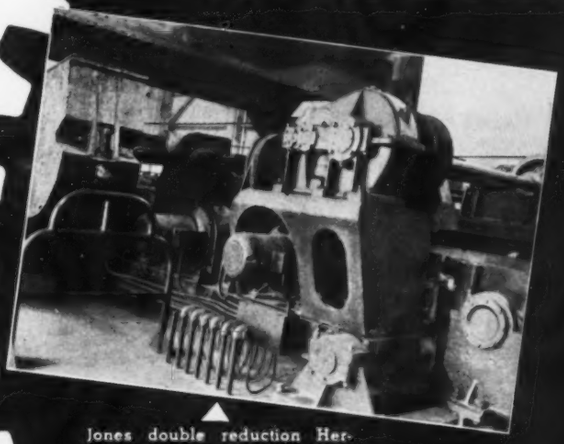
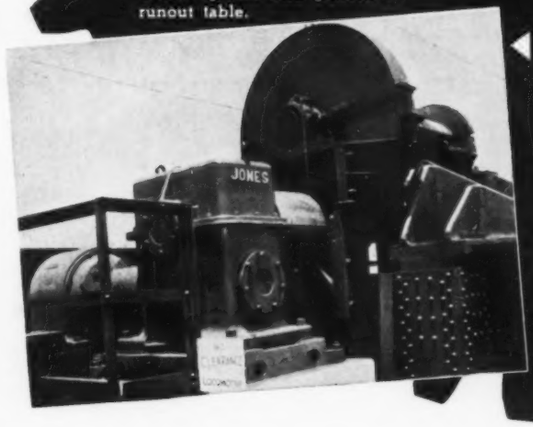
JONES DRIVES
in the Steel Industry



Jones double reduction Herringbone Reducer driving blooming mill slab pusher on runout table.

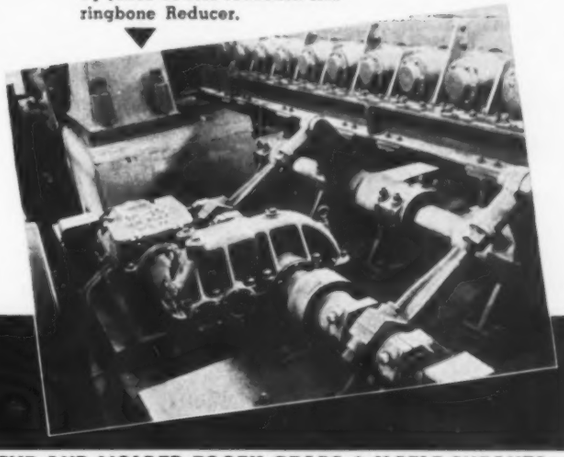
Carriage travel for cold strip processor driven by Jones worm gear.



Jones worm gear driving blooming mill crop conveyor.

Jones triple reduction Herringbone Reducer driving blooming mill shear approach table — adjustable side guards.

Blooming mill scale lift driven by Jones double reduction Herringbone Reducer.



● There are many sound reasons why Jones Herringbone and Worm Gear Reducers have been selected for these and many other applications in the steel industry . . . reasons which we believe you will also find sound and convincing when you are considering your drive problems. In any case we shall be pleased to place complete information in your hands covering speed reducers and other Jones transmission products.

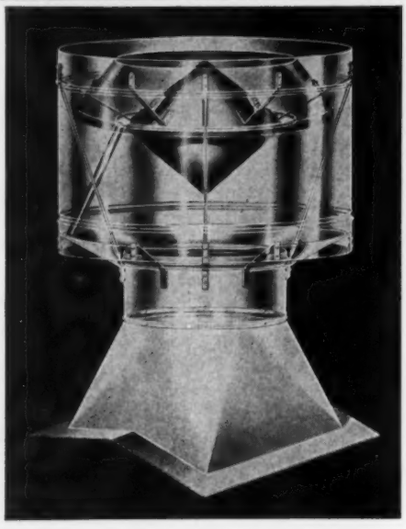
W. A. JONES FOUNDRY & MACHINE CO.
4431 Roosevelt Road, Chicago, Illinois

Jones

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS • CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES
ANTI-FRICTION PILLOW BLOCKS • PULLEYS • FRICTION CLUTCHES • TRANSMISSION APPLIANCES

BURT

FREE-FLOW GRAVITY VENTILATORS



Fulfill Exacting Requirements of the Irvin Works

This company is justly proud of the selection of its Free-Flow Gravity Ventilators for the Irvin Works construction. This selection is illustrative of the ability of the Burt line to meet the exacting requirements of steel mill ventilation.

Like all Burt ventilators for industrial use, this unit is designed for maximum efficiency and is of rugged construction for long life and low service cost.

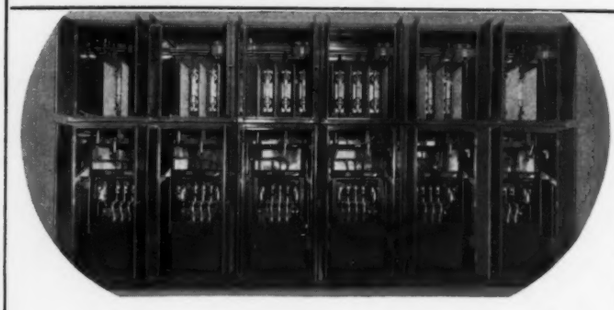
The Free-Flow Gravity Ventilator, together with its companion units, the Free-Flow Fan and the Monovent Continuous Ridge Ventilator, presents the correct solution of your ventilating problems. Detailed data, job references and engineering assistance will be furnished promptly.

THE BURT MFG. CO.

Roof Ventilators - - Oil Filters - - Exhaust Heads

950 SOUTH HIGH ST. AKRON, OHIO

COMPLETE CONTROL UNITS



These Rowan complete control units for 2300 volts are regularly supplied singly or in banks as desired.

The above pictured units each consist of: push-button operated oil immersed starter, fused disconnects, insulated bus, bus insulators, self-contained control potential transformer and a one-man tank lifter. Provisions are made for incoming and outgoing conduits for both motor and control circuits in a sealed-off terminal box.

THE ROWAN CONTROLLER CO. – 25TH ANNIVERSARY 1914–1939 – Baltimore, Md.

ROWAN CONTROL

MR. A. L. LINK *in the* BUFFALO AREA

Mr. Link will be glad to explain in detail the new "Seal-Off" wiring compartment and safety jack incorporated in the Silver Anniversary design of the Rowan 780-KBF Oil Immersed Combination Line Starter and Safety Disconnect Switch for A. C. motors.

BUFFALO OFFICE
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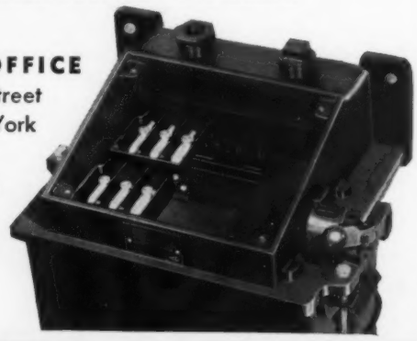
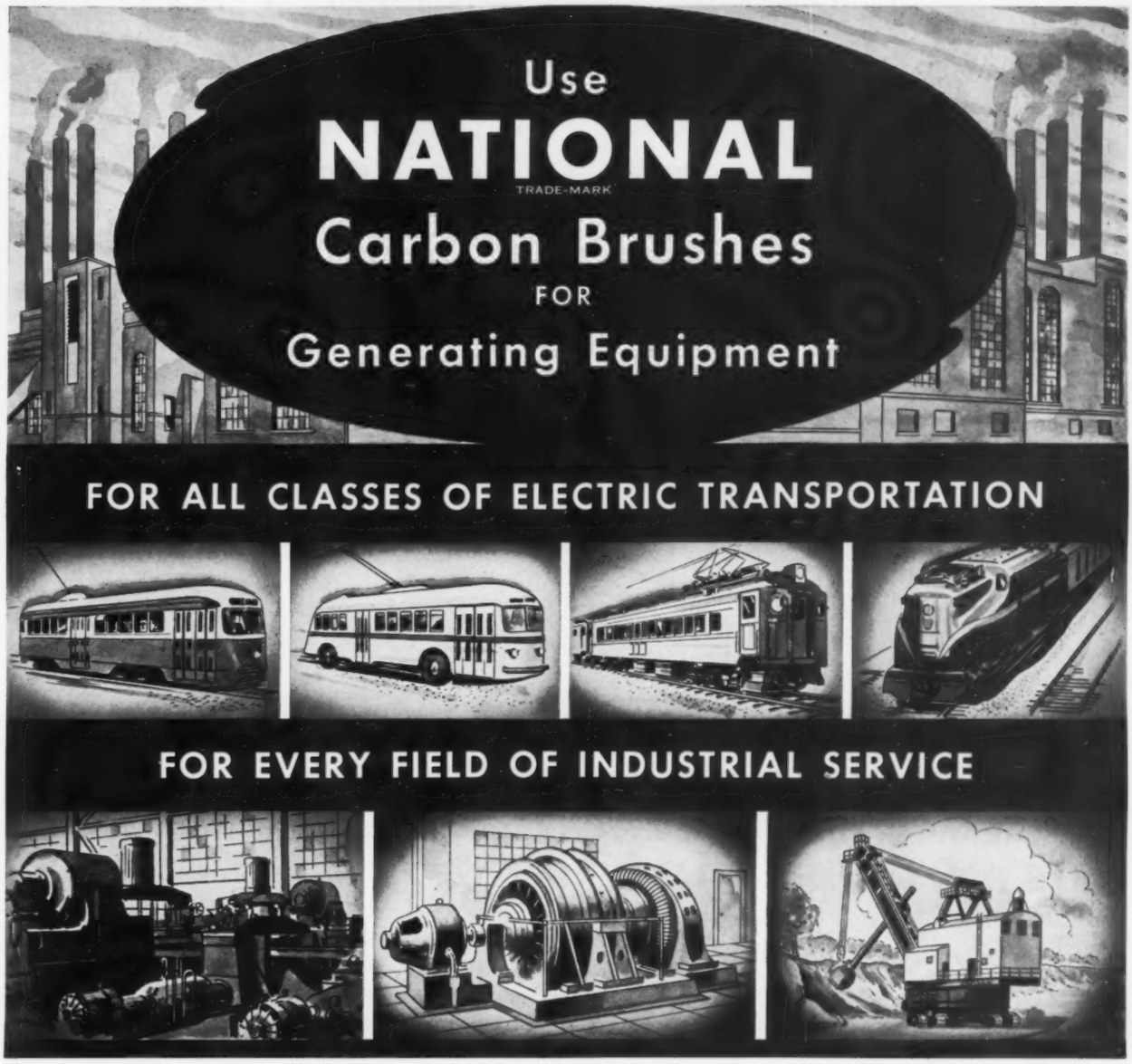


THE ROWAN CONTROLLER CO. – 25TH ANNIVERSARY 1914–1939 – Baltimore, Md.

ROWAN CONTROL



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YET ITS PRESENCE IN YOUR PLANT COSTS YOU A "PRETTY PENNY"

Banish this PROFIT THIEF COMPLETELY and AT LOW COST with AMERICAN "DUSTUBE" DUST COLLECTORS

The *American* "Dustube" Dust Collector is the choice of leading industrial concerns because:

(1) Its tubular design and simplicity insure low operating and low maintenance costs.

(2) The absence of rigid screen frames permits thorough cloth cleaning and eliminates corrosion and cloth wear through contact with metal frames and wires. Each "dustube" is an independent cell which can be replaced in a few minutes.

(3) An improved shaker insures lower back-pressure range, longer cloth life, and less power consumption.

(4) The ample spacing of the dustubes decreases the resistance to air flow and saves fan horse-power.

(5) Carefully designed inlet and expansion chambers insure uniform distribution of air and maximum "dustube" life.

(6) High efficiency: *By weight:* 98% and more. *By dust count:* discharged air shows less than ten million particles, from 2 to 10 microns in size.

For complete details write for Book No. 22.

THE AMERICAN FOUNDRY EQUIPMENT CO.
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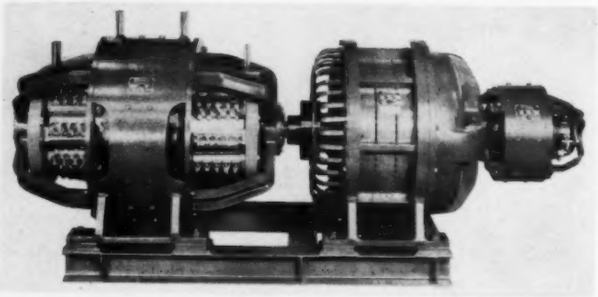
COLUMBIA

MOTOR-GENERATORS



5,000 ampere, 6 volt, 600 R.P.M., 3 bearing Columbia synchronous motor-generator set with direct connected exciter.

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4505 Hamilton Ave. Cleveland, Ohio

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—the only multi-range ammeter which will measure either A. C. or D. C. instantly!

TONG TEST
—the only multi-range ammeter offering a selection of 10 individual ranges up to 1,000 amperes!

TONG TEST
—the only multi-range ammeter which contains no windings — cannot burn out! Weighs only 2¾ lbs.

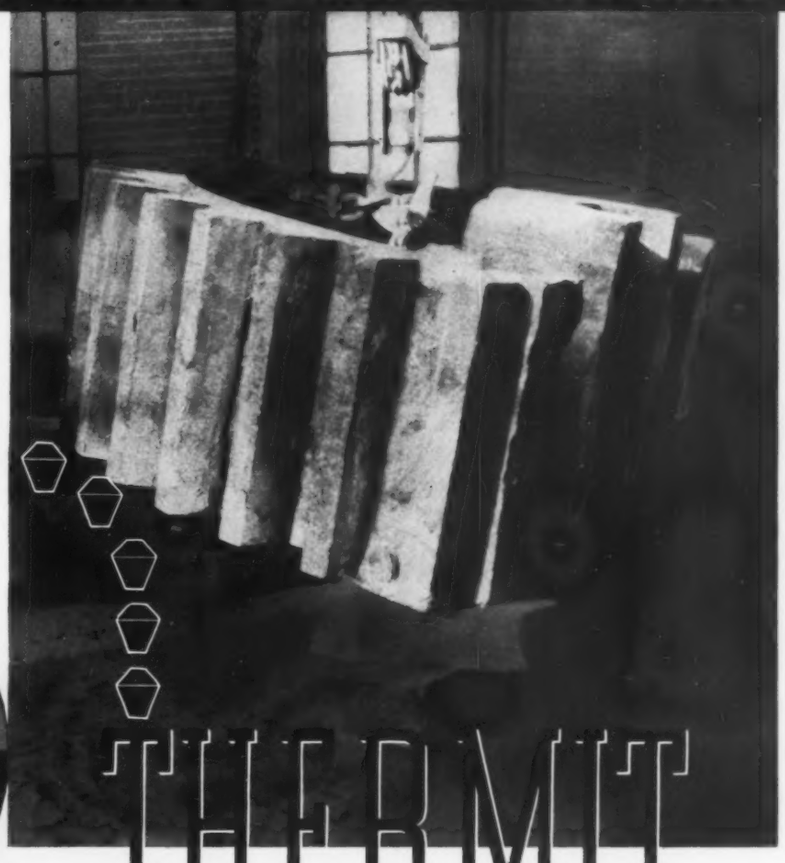
Seeing is believing! Let us arrange a demonstration of the Tong Test and Volter, a voltage measuring attachment — or send for your Tong Test bulletin.

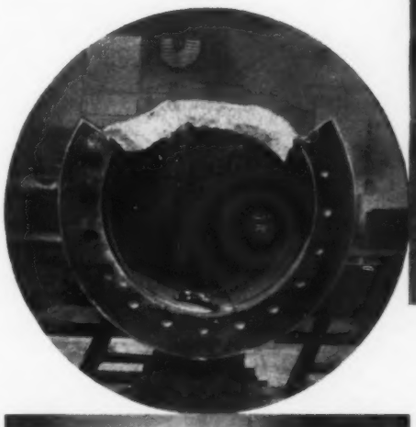
COLUMBIA ELECTRIC MFG. CO.
4505 Hamilton Ave., Cleveland, Ohio

TONG TEST AMMETERS

FOR LARGER MAINTENANCE SAVINGS—

Repair and *Reclaim* with





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● Savings effected by Thermit Welding are invariably substantial.

Broken crankshafts, for example, can be repaired the Thermit way at a small fraction of replacement cost. Emergency welds are readily made, also, to broken housings, charging peels, pinion teeth and wobbler ends. Or, parts may be salvaged from the scrap pile, welded and set aside as spares.

Thermit welding prevents long, costly shut-downs, too. Permanent repairs are made quickly the Thermit way so that broken parts can be returned to service in a day or two, whereas to replace them may involve weeks of delay.

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Most Short Circuits In Motors Can Be Prevented!

Nearly always they are due to oil escaping from bearings and soaking windings. The result is a short circuit and "burn-out".

NON-FLUID OIL stops this trouble. It does not leak or creep, nor is it thrown out of bearings by vibration. Motors are kept running steadily, with cool bearings and clean frames. Money is saved on lubricant and application cost, because NON-FLUID OIL lasts longer and needs less frequent renewal.

Used successfully in leading iron and steel mills. Send for testing sample today—prepaid —NO CHARGE.

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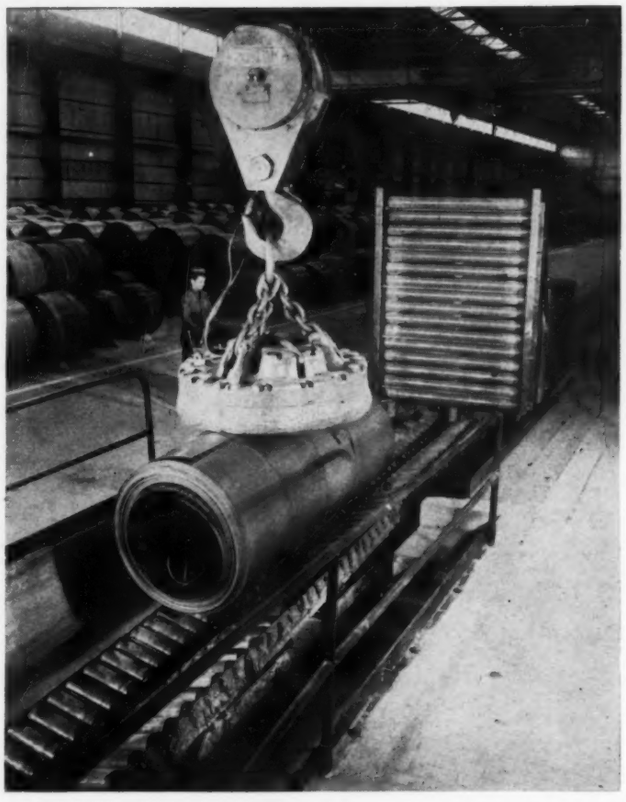
MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

Ohio Magnets

Can do many jobs efficiently



Above is a standard 55″ Ohio Magnet lifting two 7350 lb. Coils from the Hot Mill Conveyor to Raw Coil Storage.

This is the hardest way to lift coils with a magnet and it illustrates their unfailing usefulness.

We also make magnets for special purposes. What is your problem?

The Ohio Electric Manufacturing Company

5907 Maurice Ave., Cleveland, Ohio

POOLE
Flexible Couplings

FULLY LUBRICATED
DUST PROOF
OIL TIGHT

ALL METAL
NO WELDED PARTS
FREE END FLOAT

It gives full compensation for the unavoidable errors in alignment or those caused by changes of temperature, wear of bearings, vibration, etc. It also permits free lateral float to connected shafts, and prevents torsional motions. Stronger than the connecting shafts. Capable of sudden reversals at high speed or heavy duty, slow speed drives without strain to the coupling or the machinery it connects. Simple in design, no springs, pins or bushings, self-aligning, silent and vibrationless at all times.

Send for a copy of our

Flexible Coupling Handbook

NO. 26 POOLE HEAVY DUTY CAST STEEL MILL TYPE FLEXIBLE COUPLING SHOWN IN ILLUSTRATION ON THE RIGHT.

TOTAL WEIGHT 15 TONS.

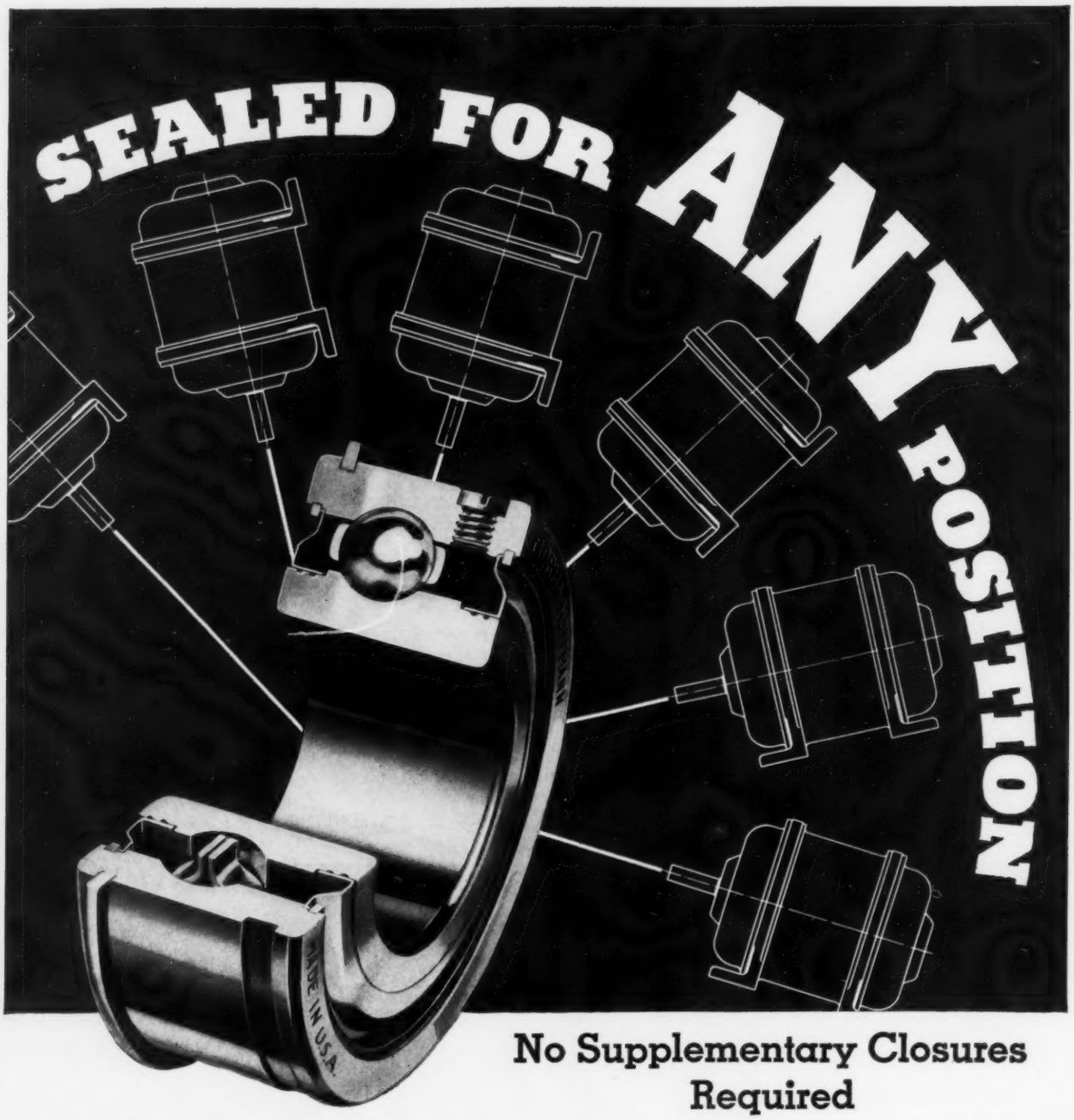
THIS COUPLING USED ON BLOOMING MILL DRIVE

38,000 HP. AT 100 RPM.

OUTSIDE DIAMETER 77".

POOLE FOUNDRY & MACHINE COMPANY

BALTIMORE, MARYLAND



No Supplementary Closures Required

Regardless of the angle of the shaft—horizontal, vertical, or in between—the "CARTRIDGE" BALL BEARING seal, with its long flange, minute clearance, recessed inner ring construction and multiple grease grooves, KEEPS THE GREASE IN AND THE DIRT OUT.

Thoroughly tested in our own laboratory over a protracted period, and in the field under continuous duty, the "CARTRIDGE" BALL BEARING has demonstrated not alone its value but its SUPERIORITY.

One of the largest motor manufacturers equipped a vertical motor with "CARTRIDGE" BALL BEARINGS and after running it on test over four years, nine hours a day, five days a week, writes:—"*we have added no grease to either bearing and have observed no leakage*". This test motor is still running, with the same results.

Adopt the fully-sealed "CARTRIDGE" BALL BEARING as absolute protection against leakage, neglected lubrication, and dirt and grease contamination. It also eliminates numerous supplementary closure parts, machining operations and variables, and speeds up production. Moreover, it has convenient regreasing and inspection features.

Write for the Catalog. Let our engineers work with you.

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.

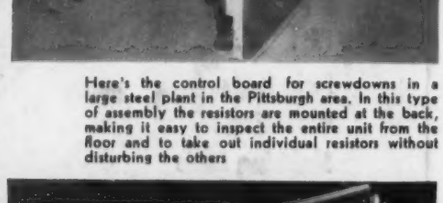
LESS COST *per Ton of Steel Rolled with* PHOENIX ROLLS

A MILE

and Thousa[illegible] Installation EXPE[illegible]

These Recent Installations Illustrate Two Popular Types of G-E Factory-assembled Control

Here's the control board for screwdowns in a large steel plant in the Pittsburgh area. In this type of assembly the resistors are mounted at the back, making it easy to inspect the entire unit from the floor and to take out individual resistors without disturbing the others



This is the control board for auxiliary drives installed in a hot-strip mill in the Midwest. The unit consists of two groups of panels, arranged back to back, with the resistors for each mounted overhead. This arrangement cuts the over-all length of the installation in two and facilitates locating the control in the middle of the motor room or close to the motors

Nearly 5300 feet of G-E factory-assembled control in steel-mill service is impressive evidence that steel companies clearly recognize the great savings in installation time and expense made possible by *complete* factory assembly.

These companies have found that with G-E factory-assembled control (self-supporting type), it is only necessary to set the units on the floor and connect the power supply and leads to the terminals. The panels, main buses, and resistors have already been assembled on rigid, self-supporting framework and have been wired and tested. As a result, users have been able to save materially on *total* control installation expense.

The installation of this G-E control in a new mill just before the start of operations has saved valuable time at a crucial moment. And in plant modernizations it has helped to shorten the change-over period, lessening the down time of the mill.

COMPLETE FACTORY ASSEMBLY MEANS:

1. Group of panels mounted on a framework is installed as a unit.

2. Resistors are mounted on same framework, each being wired to its corresponding panel. There are no resistor boxes to sort, stack, and connect.

3. Power bus is supplied with each panel group.

4. Each panel is connected to power bus. Only one power feeder must be connected to power bus.

5. Terminals are conveniently located at each panel for quick connection to outgoing motor and control leads.

6. Fewer shipping crates to handle.

Since the installation of the first units in 1935, G-E engineers have made continual improvements in the design and construction of factory-assembled control. Why not get in touch with our nearest representative and have him give you full information about it? General Electric Co., Schenectady, New York.